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Journal of Chemical Education

Published by

Division of Chemical Education of The American Chemical Society

Easton, Pa.

Entered as Second-class Matter, January 31, 1924, at the Post Office at Easton, Pa., under the act of March 3, 1859. Accepted for mailing, at special rate of postage provided for in Section 1103 Act of October 3, 1917, authorized January 31, 1924.

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The Journal of Chemical Education is indexed in the Education Index and Industrial Arts Index

Vol. VIII **February, 1931** **No. 2**

CONTENTS

	Page
Editor's Outlook:	
Albert Einstein	207
Usurped Authority	209
Introducing Chemistry	210
The Liebig Laboratory and Liebig Museum in Giessen. ROBERT SOMMER	211
Liebig's Student Days. ERNEST R. SCHIERZ	223
The Other Oxides of Carbon. KENNETH A. KOBE	232
Early Portraits of Benjamin Silliman. LYMAN C. NEWELL	240
A Science Fair. GEORGE N. CAROTHERS	244
How Times Have Changed! A Playlet in Two Acts. LOUIS C. JORDY	256
The Problem of the One-Year Course in Chemistry for the General Student. GERALD WENDT	270
The Freshman Course in Chemistry for Students Who Have Had Secondary-School Chemistry. STUART R. BRINKLEY	285
Why Every College Has a Course Called Chemistry I. JOHN D. CLARK	290
Student Guidance. I. The Selection and Sequence of Courses Outside the Major Field. W. A. MANUEL	294
Demonstration Experiments and Their Place in the Teaching of Chemistry. ARTHUR B. GOULD	297
Lecture Demonstrations in General Chemistry. JAMES H. WALTON	303
The Quantitative Trend in General Chemistry Laboratory Courses. R. D. BILLINGER	307
The Study of Isomerism in Courses in General Chemistry. JOHN C. BAILAR, JR.	310
A Simple Device for Illustrating on a Plane Surface the Projection Formulas of Organic Compounds. SISTER M. ALOYSE ELLINGSON	316
Glass versus Slate Blackboards. FOSTER DEE SNELL AND BEATRICE S. FOX	320
The Sectioning Problem in General Chemistry. A. J. CURRIER	328
The Low Student in General College Chemistry. ROBERT AMBROSE OSBORN	331
A Study of the Need for Junior Laboratory Technicians in the Chemical Industry of Essex County, New Jersey. HERMAN A. ERNST	334
Detection of Fluorides Using the Zirconium Lake of Alizarin. IRWIN STONE	347
A Method of Dispensing Qualitative Unknowns. WILLIAM O. SWAN	350
Molecular-Weight Apparatus for the Boiling-Point Method. EDWARD M. HOSHALL	353
A New Type of Electrically Heated Muffle Furnace. T. R. BALL	355
Positions Open in Various Colleges and Universities to Graduate Students Majoring in Chemistry	358
J. T. Baker Chemical Co. Analytical Research Fellowships for 1931–32	366

Correspondence:

Centigrade-Fahrenheit Temperature Conversion. ALFRED M. EWING..... 370
HERMAN W. WOODS..... 370
A Show Window for the Chemistry Department. RICHARD L. FELDMAN.... 371

Chemical Digest:

Science Makes Marked Progress during 1930..... 373

Abstracts:

Apparatus, Laboratory Practice, and Demonstrations..... 380
Teaching Objectives, Methods, and Suggestions..... 381
Administrative Problems and Devices; Curricula..... 381
Keeping Up with Chemistry..... 381
Scientific Reviews and Bibliographies..... 383
Historical and Biographical..... 383
Educational Measurements and Data..... 385
The Philosophy of Education..... 386
Professional..... 388
Contemporary News and Comments in Chemistry and Education..... 389
Foreign Chemical and Educational Conditions..... 390
General..... 390

Contemporary News in Chemistry and Education:

Indiana University's New Chemistry Building. ROBERT E. LYONS; American Association for the Advancement of Science; Pernicious Anemia Cure Wins *Popular Science Monthly* Award; Cancer-Causing Substances Flash Danger Signal; Announcement of Third International Congress on Bituminous Coal; Thirteenth Exposition of Chemical Industries, New York City; Second Annual Meeting of the Society of Rheology; Government Scientist Announces Final Value for Gravity Constant; Simple Chemical May Replace Liver as Anemia Cure; Mellon Institute Announces Industrial Fellowship on Sugar; National Advisory Committee on Education; Changes in Organization at the University of Chicago; European Study Tours for American Educators; Enrolment of Teachers in Summer Schools; South Dakota Education Association; Anniversary Meeting of the Royal Society; Lectures at Cooper Union; Dakota Wesleyan University; Hastings College Chemistry Club; Dr. Koch Lectures at De Paul University; Missouri School of Mines; Washington University; Department Activities at the College of the City of New York; Chemistry Research at the State University of Iowa..... 392

Recent Books..... 411

EDITOR'S OUTLOOK

Albert Einstein, 1879–

"WITHOUT the sense of collaborating with like-minded beings in the pursuit of the ever-unattainable in art and scientific research, my life would have been empty. Ever since childhood, I have scorned the commonplace limits so often set upon human ambition. Possessions, outward success, publicity, luxury, to me these have always been contemptible. I believe that a simple and unassuming manner of life is best for every one, best both for the body and the mind." The man who made this declaration a necessary part of his philosophy of living in a statement for the American public several months ago was met on his arrival in this country a few weeks later, on his way to the California Institute of Technology and the Mount Wilson Observatory for consultation with fellow-scientists, with the uproarious reception that the self-appointed representatives of that public accord with equal favor to notoriety and to fame. But Einstein, the man of simple tastes and habits, the scientist absorbed in speculation and disdainful of empty popularity, has very human sympathies and so with patience and good humor he received the welcome of the American people, ignoring its lack of discrimination and accepting for science the generous fervor offered to his own personality.

Dr. Einstein comes from Berlin, where he is the director of the Kaiser Wilhelm Institute for Theoretical Physics. He holds also a professorship at the University of Berlin, a post to which he was appointed in 1914 under the Prussian Academy of Sciences. It was only the freedom of the terms of this appointment, which involves few official duties and no regular teaching, an independence which his work demanded and for which he had longed, that drew him away from Zürich where he had been a professor at the Confederate Polytechnic Institute.

In Switzerland, from his early youth, Einstein has recognized his true home, although he was born of German Jewish parentage at Ulm (March 14, 1879) and spent his boyhood in Munich. A shy and dreamy child, sensitive to impressions of art and nature, nourishing even then a loneliness of spirit which has survived to manhood in spite of close and cherished friendships and a diversity of interests, he was ill-suited to the formal disciplines of the Munich elementary school which he attended. Although he excelled in science and mathematics, so far as to learn analytical geometry and calculus at the age of fourteen without aid except for textbooks, his precocity did not extend to other subjects which were necessary for university entrance. At fifteen, due to his parents' financial reverses, he was faced with the necessity of choosing a line of training which would prove eventually lucrative, and the boy, whose visions of life and activity were so far removed from the practical, went to Switzerland where after a year's preparation at Aarau he entered the Confederate Polytechnic Institute of Zürich. Here he plunged into the study of

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physics. Not content with the courses offered at the institute, he followed a very wide line of reading, not in science only, but in philosophy and general literature. He was supported during these university years by a small allowance from relatives, out of which income, by privations difficult even for one of his simple habits, he managed to save a sufficient sum to purchase the naturalization papers which conferred upon him Swiss citizenship, a privilege he has retained throughout his life and which served him in good stead during the World War when it protected the neutrality of this ardent pacifist.

His university training over, Einstein looked forward to a teaching appointment, which he was unsuccessful in obtaining. In 1902 he secured a position in the Confederate Patent Office at Bern. He was not unhappy in the humdrum duties of this office, for it gave him time to pursue his studies in theoretical physics, so that in 1905 he passed his examination for the doctorate and published his first formulation of the theory of relativity. His work on the general and special phases of this theory thenceforth progressed steadily through the remaining years at Bern, throughout the term of his professorships at the Universities of Zürich and Prague and the Confederate Polytechnic Institute of Zürich, and into the independent atmosphere of his present post at Berlin. The development of the theory, on which his fame chiefly rests, worked itself out not so much by means of publication as in correspondence with the friends he has made throughout his professional career, notably the German physicist Planck, who was instrumental in bringing him to Berlin, the Dutch mathematician Lorentz on whose calculations Einstein's theories partly rest, and the Danish physicist Bohr.

The Nobel Prize in physics for 1921 was awarded to Einstein "independently of such value as may ultimately be attached to his theories of relativity and gravity, if these are confirmed, for his services to the theory of physics, and especially for his discovery of the law of the photo-electric effect."

While Einstein's scientific activity has been confined entirely to one field, his personal interests have been anything but narrow. Music has been the chief outlet of his aesthetic nature. A youthful impression of social injustices and inequalities bred in him a passion for social adjustment which has found constant and practical expression in recent years, particularly since the World War and its consequences intensified in Germany and elsewhere conditions of life that appeal to his compassion and benevolence. One evidence of this has been his alliance with the Zionist movement, which alliance came about, not through the ties of blood or religion which had long been weakened in him, but through his sympathy with an oppressed people. For the world in general he entertains the hope of universal peace—with him it is an ideal which takes

shape in doctrine and he loses no opportunity to preach the gospel of its ultimate attainment by way of intellectual understanding among men and nations.

Usurped Authority

THERE seems to be a widespread human delusion to the effect that genius and wisdom are general characteristics of the individual. Let a man attain prominence in any field of endeavor whatsoever and immediately his opinions and speculations on every subject are received with respect and even sought after. Unfortunately, successful men are not always immune to this aberration of intellect. Many of them seem to believe that in their particular cases at least the popular notion is justified.

One might hope that scientists, accustomed as they are to view things objectively and critically, might escape the general affliction—but not so. In fact, attention to recent and contemporary history suggests that they are peculiarly susceptible to it. A great chemist abandons chemistry to become a fifth-rate philosopher; a great physicist takes up table-rapping and spirit communication; a great inventor speculates upon the nature of the life force and the underlying secret of biological processes; others try their hands at metaphysics and the higher criticism.

All of the men we have in mind are, by almost any standard one cares to apply, our betters. Hence any reproof directed from us to them would be not only ineffectual but, in a sense, an impertinence. Perhaps, however, we may, without impropriety, help to swell the applause when one less obscure than ourselves enunciates a few wholesome truths.

As reported in a recent *Science Service* note, Dr. E. T. Bell of the California Institute of Technology and vice-president of the section on mathematics of the American Association for the Advancement of Science, spoke in part as follows at the Cleveland meeting:

> Most reputable physicists, I presume, would believe that they agree with Dirac, that "the only object of theoretical physics is to calculate results that can be compared with experiment," even when some of them proceed to apply theoretical physics to speculations whose very nature precludes comparison with experiment. A similar remark applies to any science speculating outside its own specialty. The speculations as a rule are of but slight interest to specialists, and only the layman, who cares little for the dry technicalities of science, is taken in.
>
> We are all laymen and largely ignoramuses outside our own narrow specialties. In particular the mathematician looking at physics is merely a layman, and the theoretical physicist using mathematics is in general a mathematical layman.
>
> Only when the mathematical layman and the scientific layman meet on the common grounds of speculation or hypothesis does either believe in his heart that he can show the other anything with which he is not utterly incompetent to deal. On these debatable grounds the last word belongs as a rule to the most vociferous and the most credulous, and the interested bystander, who is neither a mathematician nor a scientist, goes away

convinced that he has heard at least an echo of the eternal truth, whereas he has only been richly muddled by a loud noise.

What the respective professionals suspect of being mere hypothesis, rank conjecture, or baseless aspiration, although occasionally one is simple enough to deceive himself and gloss his suspicions for the benefit of the complete layman, passes for established fact in the uncritical mind, which hungers to be convinced of something, no matter what.

The sort of activity which Dr. Bell deplores is in itself a harmless enough intellectual diversion—entitled to rank somewhat above contract bridge and somewhat below chess. The effect upon the general public is, however, unfortunate. The average layman is perhaps able to grasp the fact that a scientist may speak either as the mouthpiece of science or as a private individual, but he is seldom capable of recognizing which of the two rôles has been assumed at any given time. Even when he is not confused on this point he is entirely too ready to assume that the philosophy, let us say, which he imbibes is the product of the same mind and the result of the same type of reasoning process which has evolved some great contribution to science. He seldom suspects that dual personality may extend far below the surface. The result is that some extremely weird dicta are quoted from the public rostrum and in the public press, prefaced by the phrase, "Science has demonstrated that . . . ."

We do not advocate an organized censorship of any kind but we suggest that the unwritten code of scientific ethics be generally construed as debarring scientists from speaking in public on subjects outside the fields of their own specialties, and as requiring the signature of a *nom de plume* to all non-scientific and pseudo-scientific writings. Special dispensations might be granted to after-dinner speakers so long as they confine themselves to such subjects as Pat and Mike, the traveling salesman, *et cetera*.

Introducing Chemistry

REALIZATION of the fact that learning is already too departmentalized and threatens to become more so has led to experimentation with various remedies and palliatives. One device which has been widely, if tentatively, adopted is the freshman orientation lecture course. In this number Professor John D. Clark of the University of New Mexico presents the outline of a lecture on chemistry designed to serve as one of such an orientation series. The author disclaims any desire to offer a model and hopes only that his outline may serve the dual purpose of presenting a few usable suggestions and of stimulating further contributions of this nature. Whether a similar lecture be given as one of an orientation series or as the first in a course in general chemistry, we feel that some such introduction to the subject is not only highly desirable but well-nigh essential.

THE LIEBIG LABORATORY AND LIEBIG MUSEUM IN GIESSEN*

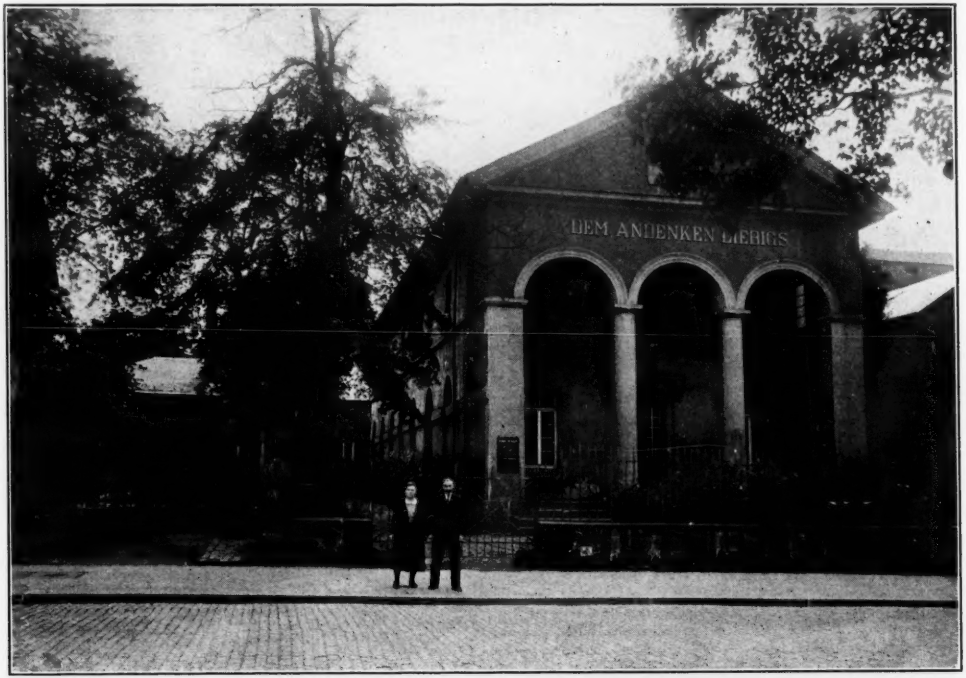
ROBERT SOMMER, UNIVERSITY OF GIESSEN, GIESSEN, GERMANY

In 1824, when Justus Liebig received his appointment at Giessen, the university there had no real chemical laboratory. The young professor, then only twenty-one, had learned from his own student career the absolute necessity of laboratory facilities in the effective teaching of chemistry and, due largely to his insistence, the authorities placed at his disposal one of the two large guard-houses of the barracks which stood in what was then the south side of the city. These quarters had been vacated by the military and given over to the university. From this small building whose original appearance can still be pictured from the neighboring colonnaded guard-house, there developed, as a result of several building programs spread over about twenty years, the famous Liebig Laboratory in Giessen.

After the chemical activities of the university were transferred to the new building on the Ludwigstrasse in 1888, the old laboratory served divers and extraordinary purposes. For example, the oldest part housed the Hygienic Institute for a time; and the world-famous analytical laboratory, built in 1842, was used for clinical purposes after removing all the original equipment, whose great historical interest was held of no value. In 1907, the buildings were vacated by the clinics, and turned over to the municipality, with no provision for preserving the old laboratory. The latter was almost an utter ruin, and efforts to reconstruct the Liebig Laboratory and to use it for museum purposes seemed to be "love's labor lost." From about 1900 on, the writer stood alone in this endeavor and for ten years he met single-handed the opposition from various interests. The project at times seemed hopeless and it appeared that the tangible evidence of Liebig's activities in Giessen was fated to be lost. The city authorities planned to use this part of the barracks as a dental clinic.

The tide was turned by a lecture which the writer delivered in the winter of 1910–11 before the Historical Society of Upper Hesse. On that occasion he showed the sketches of Giessen and the Liebig Laboratory made by the Finnish artist, Frederick Soldan, in 1848. The writer made a plea for aid in his plan to conserve and recondition this famous chemical monument and a committee was appointed. It sent out appeals to the chemical world, and actually secured funds for the first repairs and for the reconstruction of the hearths. The details of the various phases of progress are recorded in the minutes of the Museum and only a brief account will be given here of the fruits of these twenty years of effort.

* Translated by RALPH E. OESPER, University of Cincinnati. For an account of the events that led to Liebig's appointment at Giessen, his reception there, his organization and development of the laboratory facilities, and views of the interior as restored, see the translator's article, "Justus von Liebig—Student and Teacher," J. CHEM. EDUC., 4, 1461–76 (Dec., 1927).



FRONT OF LIEBIG LABORATORY AND MUSEUM IN GIESSEN, JULY, 1930

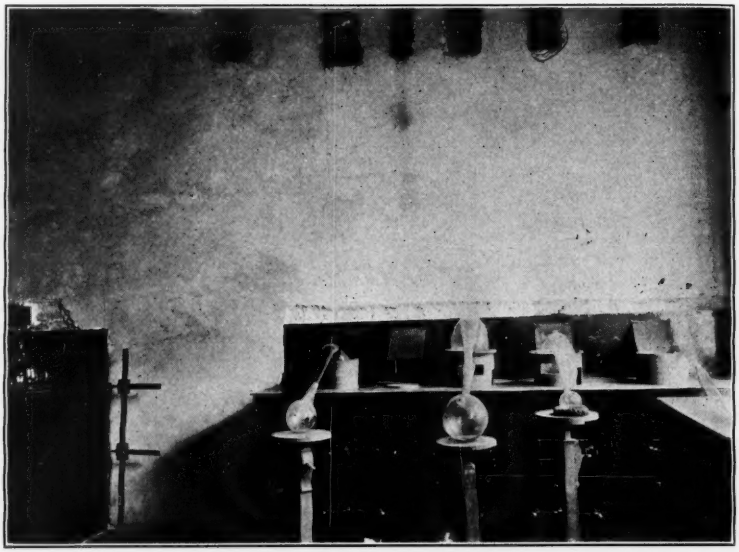
Kohut, "Justus v. Liebig," Verlag Emil Roth, Giessen, Germany

JUSTUS LIEBIG WITH HIS WIFE AND CHILDREN ABOUT 1844

This is probably the earliest photograph of Liebig. It was made by Th. Honikel, at the anatomical institute at the University of Leipsic. The exact date is not known but certainly it is of the middle forties. Liebig's youngest daughter, born January 3, 1845, is not in the picture, which indicates either that she was not yet born or perhaps was too young to have been taken on this journey, in those days a considerable undertaking.

First of all, the stability of the building was insured by repairing the roof, walls, and ceilings; in many places the joists, etc., had to be renewed. Then the chemical hearths were restored, beginning with the oldest in the original Liebig Laboratory in the old guard-room. The relation of this first hearth to its primitive forerunners was quite evident, and it was a matter of great interest to note the remarkable development exhibited in the design of the later hearths, first that in Liebig's private laboratory, and eventually the world-renowned hearth in the analytical laboratory. This whole investigation led to a reconstruction of all these heating devices so we now have here a most important exhibit of one chapter of chemical history, namely the development of chemical hearths. An investigation of the walls by percussion, as practiced by medical men, gave amazing results At various spots, in the private and analytical laboratories, for instance, hollow spaces were disclosed, in which were found historically valuable installations, such as the Liebig potash furnace.

A study of all available sources, particularly the description left by the



RECONSTRUCTED HEARTH OF THE PHARMACEUTICAL LABORATORY
This reconstruction was begun in 1914, but not finished until 1930.

builder, Hofmann, the father of Liebig's famous pupil, A. W. von Hofmann, and also the statements of the still-surviving *Diener*, Fink, enabled the writer to direct the reconstruction with some measure of competent knowledge. Not until later was the original builder's inventory made available and it then became apparent that the whole restoration corresponded quite closely with the original.

However, the mere architectural renewal of the rooms and the installation of some of the equipment, either originals or replicas, was not sufficient and the next step was to supplement and vivify these accomplishments by the assembling of other pertinent museum material. This has been made possible by the coöperation of a number of families who have donated comprehensive collections of letters and objects relating to the life and family of Liebig. In 1911 the Gesellschaft Liebig-Museum became the successor of the original committee and has since taken charge of the development of the museum. The collection has thus gradually grown to its present condition, and the following short description will be given in accord with the chronological order of the inclusion of the rooms in the laboratory scheme.

In the room directly behind the splendid colonnade, which characterizes the building on the side toward the *Liebigstrasse, i. e.*, in the old guard-room of the barracks, is the oldest hearth and a collection of cuts

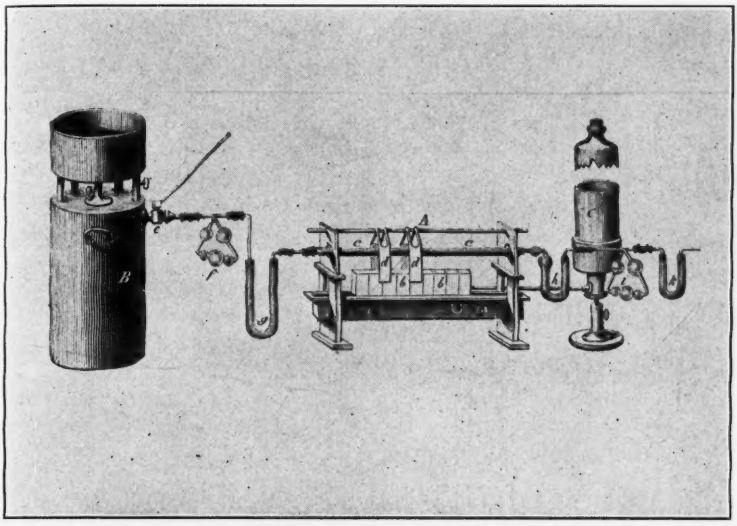
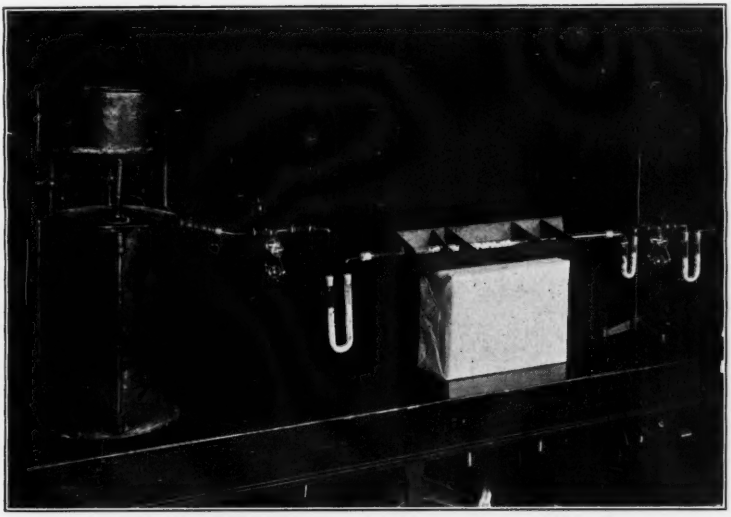
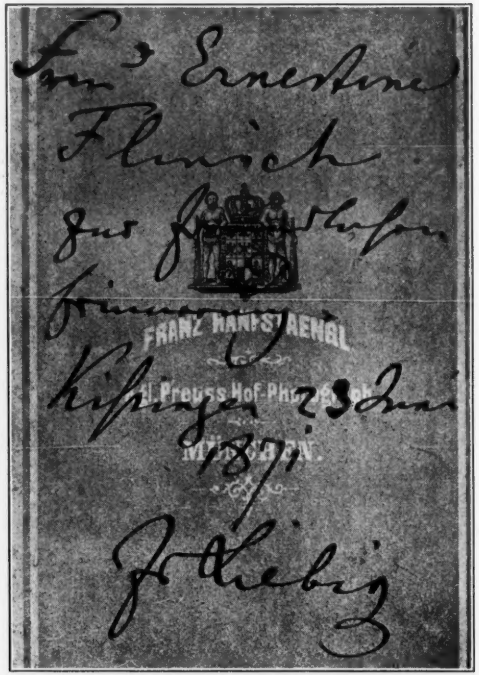


Illustration of Liebig's Apparatus for Organic Analysis Taken from His "Handworterbuch der Chemie," 1, 856 (1857)



Photograph of Liebig's Apparatus for Organic Analysis in the Museum
This apparatus was built by Dr. Hildebrandt out of original parts found in the old laboratory of Liebig.

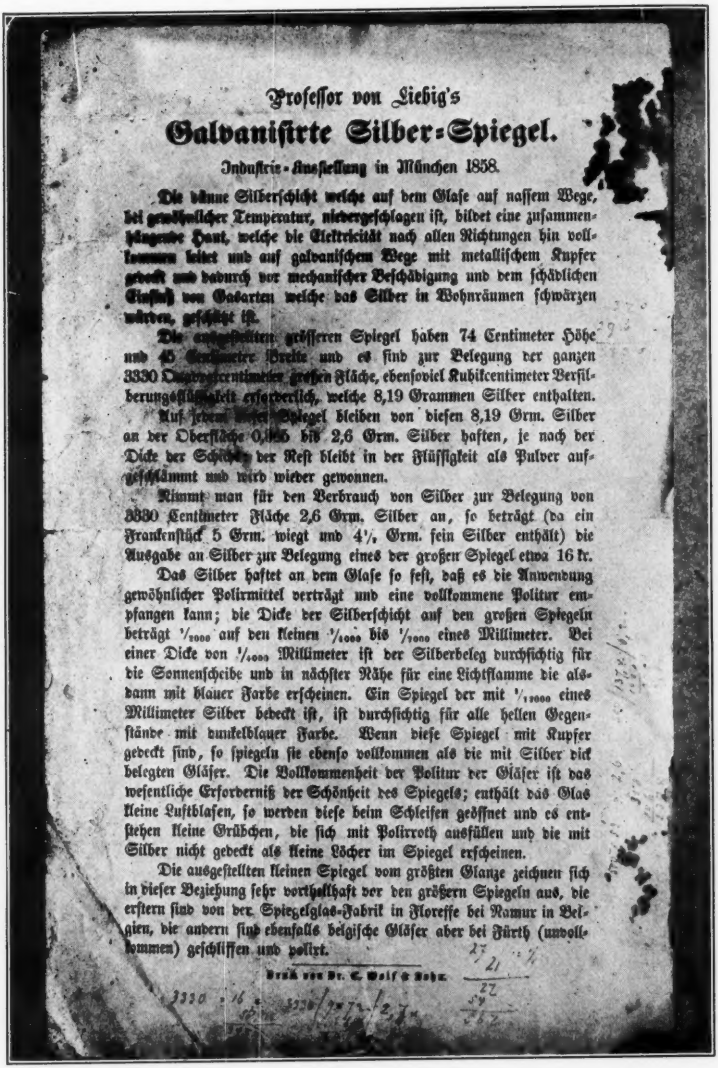


PHOTOGRAPH OF PORTRAIT OF LIEBIG MADE ABOUT 1863 WITH REVERSE, SHOWING LIEBIG'S CHARACTERISTIC HANDWRITING

A STUDENT GROUP OF THE GIESSEN LABORATORY, 1885
The surroundings in this picture are exactly as they were in 1824.

showing various forms of hearths as used since the Middle Ages. Here also is a large collection of pictures of Liebig's students, who worked with him either in this laboratory, in the later addition, or in his laboratory at Munich. Typical members of that great company were A. W. Hofmann, Will, Kopp, Kekulé, Fehling, Clemm, Pribram. This room also houses a large collection of pictures, documents, books, charts, etc., dealing with the development of experimental chemistry from alchemy, and showing the close relationship of the chemistry, pharmacy, and medicine of the sixteenth to eighteenth centuries.

Next, to the rear, is the room used by the "famulus." It contains a collection of Liebig mementoes, associated especially with Giessen and his native city, Darmstadt. Opposite is that remarkable room, used partly as laundry, partly as chemical laboratory. This is now devoted to exhibits relating to Liebig's agricultural researches: pictures and original manuscripts of his writings on this subject. It connects at the rear with the stockroom, to the left with a room formerly used for storing preparations (most of the reagents had to be prepared in the laboratory) in which are preserved memorabilia from Liebig's Munich period. Next is a short cross-hall leading to the steps to the second floor where Liebig and his family had their apartment. Behind the hall, is the extremely interesting private laboratory containing a comprehensive collection of pictures of



Professor von Liebig's

Galvanisirte Silber-Spiegel.

Industrie-Ausstellung in München 1858.

Die dünne Silberschicht welche auf dem Glase auf nassem Wege, bei gewöhnlicher Temperatur, niedergeschlagen ist, bildet eine zusammenhängende Haut, welche die Elektricität nach allen Richtungen hin vollkommen leitet und auf galvanischem Wege mit metallischem Kupfer gedeckt und dadurch vor mechanischer Beschädigung und dem schädlichen Einfluß von Gasarten welche das Silber in Wohnräumen schwärzen würden, geschützt ist.

Die ausgestellten größeren Spiegel haben 74 Centimeter Höhe und 45 Centimeter Breite und es sind zur Belegung der ganzen 3330 Quadratcentimeter großen Fläche, ebensoviel Kubikcentimeter Versilberungsflüssigkeit erforderlich, welche 8,19 Grammen Silber enthalten.

Auf jeden dieser Spiegel bleiben von diesen 8,19 Grm. Silber an der Oberfläche 0,185 bis 2,6 Grm. Silber haften, je nach der Dicke der Schichte, der Rest bleibt in der Flüssigkeit als Pulver aufgeschlämmt und wird wieder gewonnen.

Nimmt man für den Verbrauch von Silber zur Belegung von 3330 Centimeter Fläche 2,6 Grm. Silber an, so beträgt (da ein Frankenstück 5 Grm. wiegt und 4½ Grm. fein Silber enthält) die Ausgabe an Silber zur Belegung eines der großen Spiegel etwa 16 kr.

Das Silber haftet an dem Glase so fest, daß es die Anwendung gewöhnlicher Polirmittel verträgt und eine vollkommene Politur empfangen kann; die Dicke der Silberschicht auf den großen Spiegeln beträgt $^1/_{1000}$ auf den kleinen $^1/_{1000}$ bis $^1/_{1000}$ eines Millimeter. Bei einer Dicke von $^1/_{4000}$ Millimeter ist der Silberbeleg durchsichtig für die Sonnenscheibe und in nächster Nähe für eine Lichtflamme die alsdann mit blauer Farbe erscheinen. Ein Spiegel der mit $^1/_{12000}$ eines Millimeter Silber bedeckt ist, ist durchsichtig für alle hellen Gegenstände mit dunkelblauer Farbe. Wenn diese Spiegel mit Kupfer gedeckt sind, so spiegeln sie ebenso vollkommen als die mit Silber dick belegten Gläser. Die Vollkommenheit der Politur der Gläser ist das wesentliche Erforderniß der Schönheit des Spiegels; enthält das Glas kleine Luftblasen, so werden diese beim Schleifen geöffnet und es entstehen kleine Grübchen, die sich mit Polirroth ausfüllen und die mit Silber nicht gedeckt als kleine Löcher im Spiegel erscheinen.

Die ausgestellten kleinen Spiegel vom größten Glanze zeichnen sich in dieser Beziehung sehr vortheilhaft vor den größern Spiegeln aus, die erstern sind von der Spiegelglas-Fabrik in Floreffe bei Namur in Belgien, die andern sind ebenfalls belgische Gläser aber bei Fürth (unvollkommen) geschliffen und polirt.

Druck von Dr. C. Wolf & Sohn.

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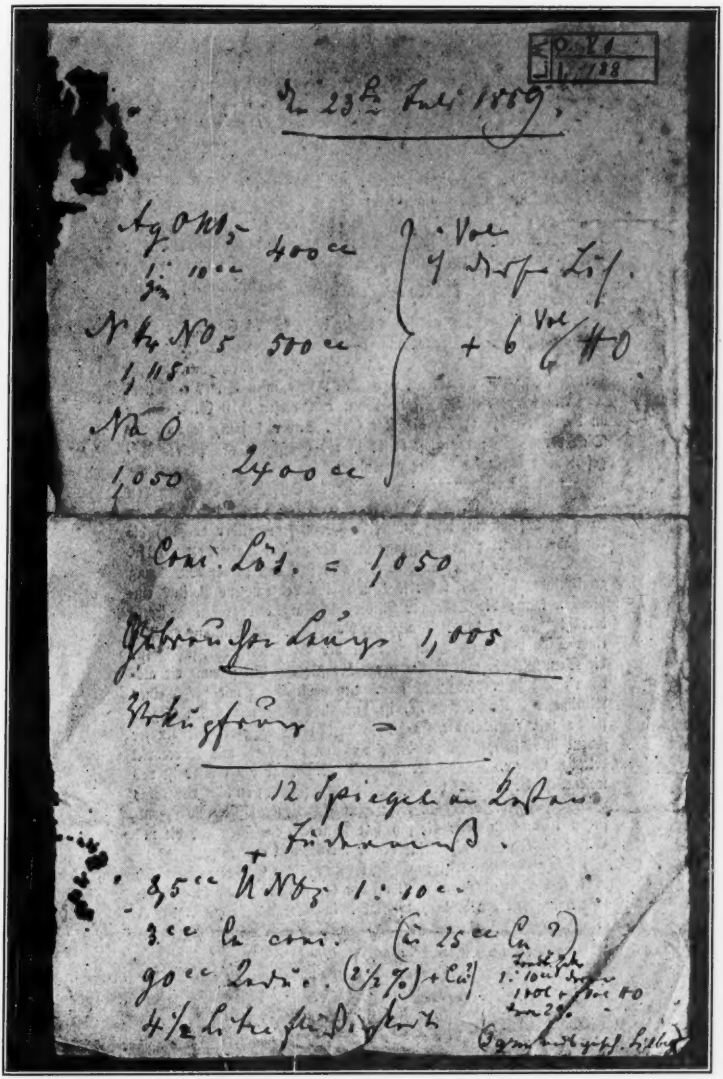
DESCRIPTION OF LIEBIG'S FAMOUS SILVER MIRROR



NOTES IN LIEBIG'S HANDWRITING REGARDING THE FORMULA OF HIS SOLUTION FOR MAKING SILVER MIRRORS

INTERIOR VIEW OF LIEBIG'S LABORATORY AT GIESSEN, FROM A DRAWING BY TRAUTSCHOLD MADE IN 1842
A description of this illustration with key is contained in an article by Friedrich Schödler in Westermann's *Jahrbuch der Illustrirten Deutschen Monatschefte*, **38**, 21–47 (1875).

LIEBIG MUSEUM MEDAL DESIGNED BY DR. OSKAR PARET OF STUTTGART

Liebig, from his youth to old age, two likenesses in plastic, 1835 and 1845, family trees, and genealogical tables. Students of family history, especially those interested in physiognomy, will find here an exceptionally rich fund of material awaiting scientific study.

The private laboratory is the last room in this wing. To this is joined the cross wing containing the new laboratory built from Liebig's plans in 1842. It contains several rooms. Directly adjoining the private laboratory is the pharmaceutical laboratory containing reconstructions of the hearths. One corner is devoted to Liebig's discovery of beef extract. To the rear is the balance room containing portraits of Liebig's contemporaries, and the library which houses a practically complete collection of originals of Liebig's publications, including the various editions of his books. In the L, farther to the left and consequently visible from the street, is the analytical laboratory, so well known because of the numerous students who worked here and also because of Trautschold's familiar sketch. Finally the auditorium, in which, as in the other rooms, the furnishings are largely the originals. The fine bust of Liebig by Wagmüller is exhibited here.

It is impossible, at this time, to discuss the extremely rich collection of Liebig letters possessed by the Museum. These donations contain comprehensive correspondence of Liebig with Hofmann, Fehling, Kopp, etc., and in some cases have been supplemented by other acquisitions. This material has inestimable value for the chemical historian and in part has not yet been worked over by the writers of the extant Liebig biographies. These letters have recently been carefully collated and cataloged, and only the lack of funds prevents the publication of this valuable catalog.

The present form of administering the Museum has justified its existence for almost twenty years and bids fair to continue its excellent work in the

conservation and further development of this Laboratory and Museum. The Gesellschaft Liebig Museum for the past several years, has evidenced its sincere gratitude to those families, individuals, and industrial concerns which have coöperated in its endeavors, by the award of the Liebig Museum Medal. This was designed, following suggestions of the writer, by Dr. Oskar Paret of Stuttgart. The gilded silver medal shows on its obverse the characteristic lineaments of Liebig and on the reverse the colonnade. A second form, in bronze, also bearing the head of Liebig, but depicting the chemical hearth on the reverse, has been struck.

The Museum is becoming better known and already has been officially visited by chemical organizations. The Liebig-Wöhler celebration held at Darmstadt in, July 1928, included an excursion to Giessen and many foreign delegates took this opportunity to inspect this cradle of chemical laboratory instruction and to honor not only Liebig's memory, but also to show their appreciation to those whose efforts have salvaged this chemical shrine and made it what it now is, a worthy monument to a great chemist and teacher.

United States Civil-Service Examination for Junior Engineer. Applications for the open competitive examination for junior engineer must be on file with the U. S. Civil-Service Commission at Washington, D. C., not later than February 10, 1931. This examination is to fill vacancies in various services for duty in Washington, D. C., or in the field. The entrance salary is $2000 a year.

The examination will consist of questions in the branch of engineering selected by the applicant and on other subjects pertaining thereto.

The branches (optional subjects) are: (1) Aeronautical, (2) Agricultural, (3) Chemical, (4) Civil, (5) Electrical, (6) Mechanical, (7) Mining, (8) Naval Architectural, (9) Structural Steel and Concrete.

Applicants must show that they have been graduated with a degree in engineering from a college or university of recognized standing; provided, that applications from senior students will be accepted with the understanding that they cannot begin work for the government until they have been graduated; and provided further, that an applicant who has completed at least two full years of engineering study at a recognized college or university may substitute acceptable experience, year for year, for the formal education lacking.

Full information may be obtained from the United States Civil-Service Commission, Washington, D. C., or from the Secretary of the United States Civil-Service Board of Examiners at the post-office or custom house in any city.

Hard and Soft Metals Make Best Bearings. Bearings in which the wheels of industry turn with least effort are made of a hard and a soft metal. It is now generally accepted that single constituent metal is not well suited for bearing purposes. The hard metal supports the load and resists wear. The soft one wears away and forms slight depressions in which small amounts of the lubricant may be retained according to Prof. Upthegrove of the University of Michigan.—*Science Service*

LIEBIG'S STUDENT DAYS*

ERNEST R. SCHIERZ, UNIVERSITY OF WYOMING, LARAMIE, WYOMING

This short account of Liebig's student days at Bonn, Erlangen, and Paris is based to a large extent on the letters he wrote to his parents during this period and in many cases he is permitted to tell his own story. His autograph album, also, in which his colleagues record the salient events of their companionship, has furnished some intimate glimpses into his student life. Attention is directed to the influence of Kastner, Schleiermacher, and v. Humboldt upon the development of the young Liebig.

. . . . . .

During a school inspection the inspector asked Justus Liebig what he was planning to become. "A chemist," he replied without hesitation. This was little short of remarkable that a fourteen-year-old boy should speak of desiring to become a chemist when no such profession existed at the time. His school career terminated although he had not completed his work. It is very probable that his antipathy for the ancient languages, which made up a major part of the curriculum in the last two years of the *Gymnasium*, was responsible for his leaving school without his *Abitur*. His father, a dealer in paints, varnishes, etc., in whose shop he first became acquainted with things chemical, knew of only one way to help his son, that being to apprentice him to an apothecary. Accordingly, Justus went to Heppenheim, not far from his native city, to the apothecary shop of one Pirsch. Liebig soon became surfeited with life in Heppenheim for he saw that it would not bring him to his goal. After ten months he returned to his father's shop in Darmstadt. Legend has it that he was sent away because of the explosion of fulminate in his attic room. A line in a letter to his parents in March, 1818, however, may give a clearer insight into his leaving. He wrote, "Mr. Pirsch is quite reasonable again and I am again contented." From other unpublished letters we learn that Mr. Pirsch was at times very unreasonable and this treatment may have contributed to Liebig's dissatisfaction.

The parents of Liebig must have been not a little disheartened to find their son returning, first unable to complete his schooling because of lack of interest and now dissatisfied with the profession they had selected in the hope of helping him. What did he do at home? He divided his time between experimenting in his father's shop and reading in the court library of the reigning Grand Duke Ludwig. The boy aroused the interest of the librarian, Hess, and the latter provided him with reading matter. As Liebig himself said in later years, "I read the books in the order in which they appeared on the shelves, from the bottom to the top, from right to

* Presented before the Division of History of Chemistry of the A. C. S. at Cincinnati, Ohio, September 9, 1930.

THE APOTHECARY SHOP AT HEPPENHEIM AN DER BERGSTRASSE AT WHICH LIEBIG SPENT TEN MONTHS AS AN APPRENTICE

From *Die Ernährung der Pflanze*, **24**, 156 (1928).

left, it was immaterial. My fourteen-year-old head was like the stomach of an ostrich for the varied contents." All the experiments described in these books for which he could acquire the necessary materials he attempted to repeat, and repeated them until he was thoroughly familiar with them.

His parents were no doubt gratified to see the interest of their son in books and his beloved chemistry. They did not lose faith in him. On the contrary, meager though their circumstances were, they arranged to send him to the university. The university of their choice was Bonn, for on its

faculty was Germany's most eminent and well-known chemist, Professor Kastner.*

In his autograph album** we find the following, probably from an intimate friend.†

In Bonn willst Du Chemie studieren
Die wird zur Alchemie Dich führen
Die wird den Stein Dich finden lehren
Den wir den Weisen nennen, hören
Du findest ihn trau deinem Glück!
O denk an deinem Freund zurück!
C. Pergay

Darmstadt 10 Octob. 1820

Liebig was happy! In one of his first letters to his parents he wrote enthusiastically about his reception at the hands of Professor Kastner and his joy in being at the university, "I am happy with my studies, the farther I get into them, the better I like it, now I begin to realize how little I know and how much I must learn in order to be able to say—'I can do something.'" He enrolled in courses in experimental chemistry, physics, and pharmaceutical chemistry.

Much of his time was spent in Kastner's laboratory. Liebig told Kastner of some of his experimental work with mineral colors, and immediately the professor suggested that Liebig have his father send him the necessary materials so that they could study the problem together. Repeating and verifying experiments described in the current literature fascinated him. Kastner was pleased with his new assistant. He even invited him to his social club.

Liebig became acquainted with a fellow student, Wöllner, whose father had a chemical plant for the manufacture of Prussian blue, sal ammoniac, acetic acid, etc. Wöllner was also studying chemistry. In fact Liebig had been tutoring him. Concerning him Liebig wrote to his parents,

> He is studying chemistry, but he has hardly any notion about it. He is so fond of me that he daily begs me to spend at least eight days of the Christmas vacation at his home. * * * * * * I am called *Privat dozent* here, because I am tutoring several medical students who wish to learn chemistry and for whom Kastner is too difficult)

* KARL WILHELM GOTTLOB KASTNER, 1783–1857. Professor at Heidelberg, 1805–12, at Halle, 1812–18, at Bonn, 1818–21, at Erlangen from 1821–56. Author of "*Beiträge zur Gründung einer wissenschaftlichen Chemie*," 2 vol., Jena, 1807/8, "*Grundriss der Chemie*," Heidelberg, 1807, "*Chemisches Handwörterbuch*," 2 vol., Halle, 1813, etc.

** Liebig's autograph album consists of loose leaves 13 × 7.5 cm. of a rough-finished paper contained in two small cardboard boxes decorated to resemble books. It is preserved with his letters and other personalia in the Manuscript Division of *Bayerische Staatsbibliothek* (Munich), where it may be consulted.

† Freely translated, Liebig's friend is telling him that the study of chemistry at Bonn will lead him to alchemy and this in turn to the philosopher's stone. He counsels him to trust his luck for he will find it, and admonishes him to remember his friend.

I hope thereby to strengthen my grasp in science, for through teaching one learns. (*docendo discimus*), * * * * * * * I am happy. I am in my element, I never go to bed before eleven or eleven-thirty at night.

After a visit to Wöllner at Christmas time, Liebig wrote his father in great detail describing the plant and the methods and suggested that his father prepare some of the mineral colors by these methods. While there the older Wöllner offered to obtain a position for Liebig in Cologne at a salary of 300 Rthlr.* Liebig refused because he believed that he was not sufficiently prepared and further because the salary did not appeal to him.

That he appreciated the sacrifices which his parents were making is apparent from his letter. He said,

Only your satisfaction and conviction that the money you spend on me is not spent in vain, spurs me on.

He was continually sending his father recipes and instructions on the preparation of materials which might aid the older Liebig in his business.

When I come to Darmstadt I will show you the plans for a lamp, the making of which costs no more than that of the ordinary street lamp and exceeds in its effectiveness about 18 times. * * * * * In order to prepare blue carmine from indigo it is necessary to add aluminum oxide.

Like the student of today Liebig was always in need of money. His letters usually contained requests for advance or additional allowances. On the first of November he wrote,

One needs very much money. I have already spent all but 20 gulden** of my current month's allowance. I am in need of woolen stockings and underwear and good vests. Those which you sent me were either too large or too small; obtain a few others instead. * * * * * * * * I found it necessary again to borrow money from Herr Markus by means of a note on you. * * * * * * During the summer semester it will be only half as expensive because heating, lighting, etc., are not necessary and because it is only $3^1/_2$ months in length.

And again from Erlangen

* * * * * * I am in need of nothing but money, because not only I but also my purse has become lean during my illness. * * * * * * The most necessary Christmas gift, which I beg of you—dear parents—can it be anything other than money? * * * * * * *. The sooner you send me money—the sooner shall you see me in D—.

In the spring, 1821, Professor Kastner was called to the University at Erlangen (Bavaria). Concerning this Liebig wrote home:

You already know that Kastner is going to Erlangen, but that he will accept me in Erlangen as an assistant you surely do not (know). He has promised me that, and if he keeps his word, I will, considering all other advantages, be able to study for 50 Taler less per half year, and I could attend all his lectures without fee. That this pleases me you can imagine. * * * * * * * *

* Rthlr = probably Taler = approximately 70 cents.

** Gulden = approximately 40 cents.

The ninth of May of this year found Liebig in Erlangen. He was well received by the *Burschenschaft.* As he said, "As soon as they learned I was from Bonn, you should have heard the noise that these fellows made, I was almost crushed by their hugging, *****." The manner in which Kastner was received on his arrival a few days later showed the esteem in which he was held. The *Burschenschaften* met him in torch-light procession with music. It pleased Kastner very much.

During this semester Liebig enrolled in botany, technology, stoichiometry, crystallography, and physics. That all subjects did not appeal to him in equal degree we learn from one of his letters.

I am getting along in botany. I have already collected 80 species. Technology is a bore, what is presented there I have heard a hundred times before.

Later in the semester he reported,

—In the public examination by Prof. Schubert in botany I received "outstanding industry and attentiveness and outstanding progress"—From K—no less.

Up to this time Liebig had been somewhat uncertain as to what field of chemistry he wished to enter. Kastner had pointed out to him the possibility of service in the teaching profession. He wrote to his parents on November 18, 1821,

* * * * * The future no longer lies dark before my eyes, I have made the decision to devote myself entirely to the teaching profession. Kastner aroused this in me, I awake as to a new life—in view of the fact that I see the goal before me, the accomplishing of which shall be my endeavor. Upon Kastner's recommendation I am going to report the analysis of a fossil during the winter which is destined to be printed in one of the journals so that I shall become known to the scientific world.

In February he writes,

You will soon see a pair of papers of mine in *Buchner's Repertorium*—Kastner is inserting them.

During this time Liebig organized a little Natural Science Society among the students. At the meetings of this group scientific questions of the day were discussed and reports made of papers appearing in the current journals. From the autograph album we learn that Liebig was the president.

Erlangen March 14, 1822 Bezold

Long live the natural history society of Erlangen and its president.

Erlangen March 12, 1822 Friedrich Engelhardt

May you never forget the Chemical Club. * * * * * *

From the description that Liebig gave of his reception in Erlangen we may understand that the social life of the student was not entirely unknown to him. On June first a group of students from Rhenish States organized a *Korps Rhenania.* Of this group Liebig was elected treasurer. The colors of the organization were blue, white, red—the motto, *virtus firmat fortes.* Organizations of this type, although prohibited, did exist. These organizations were somewhat similar to our college fraternities except that they

LIEBIG WEARING THE COLORS OF THE KORPS RHENANIA. WINTER SEMESTER, 1821–22

From a picture in possession of the *Bayerische Staatsbibliotek*, Munich.

usually had a political purpose, hence their ban. On the last day of the year the Rhenania became involved in a brawl with artizans. Naturally the police intervened and it appeared that Liebig spoke disrespectfully to those in authority, having gone so far as to strike the hat from the head of an officer and an attorney. Liebig was sentenced to three days in jail. Late in February a similar outbreak occurred but this time all the students were involved. It was the culmination of a series of little encounters between students and town's people. (The latter had organized into groups and aped the students in some of their traditional customs.) Military assistance was sent from Nürnburg but the disturbances could not be quieted. The students left Erlangen and after a day spent outside the city wall migrated to Altdorf, a former university city. After eight days they returned triumphant in a procession of ninety-three chaises with twelve mounted heralds and twenty-four mounted students. General amnesty and protection had been granted.

Pages from the autograph album as well as a letter of Liebig to his parents referred to these events; in fact they summarized his university activities.

Erlangen March 13, 1822 — Aug. Stoecklein

Our emigration to Altdorf. Our festive entry into Erlangen.

Erlangen March 13, 1822 — Paulus Ewald

Sitting together with Treck, Emmert, and Ewald and drinking to the health of Nürnburg's beautiful girls. Departure from Erlangen for Altdorf. Return via Nürnburg in 93 chaises.

G. Bischoff

Erlangen March 15, 1822 — b. Durkeim

Mem.

Our becoming acquainted in Brother Weyer's room in the summer 1821, where we emptied an oxhorn between us. The jovial time at the founding of our Rhenish fraternity. The botanical excursions. * * * * * * * Our chemical club and its jovial meetings in your room, our departure for Altdorf.

These disturbances led to governmental investigation and the existence of these semi-political organizations was officially recognized and steps were

taken to bring court action against the individuals involved. Liebig was one of the suspects. He hurried from Erlangen very disheartened.

Just at this moment Kastner came to his assistance and sent Grand Duke Ludwig a copy of Liebig's "Comparative Survey of the Systems of Chemistry." He accompanied this with a recommendation of Liebig in very complimentary terms. He said,

> * * * * * The industry with which young Liebig has studied physics and particularly chemistry under my direction, formerly in Bonn and then here in Erlangen; and the examples of his experimental proficiency which have already appeared in print arouse in me on the one hand the most sanguine hopes for his Fatherland and science, and on the other, the wish that he may increase the number of my pupils, who are already teaching chemistry with approbation and profit in the universities.* * * * * *

Liebig himself petitioned the Grand Duke for a grant (we might call it a traveling fellowship) so that he might be able to study in Paris—"at the school of the greatest chemists of the present." A grant of 330 Florins* was made.

In November, 1822, Liebig went to Paris. He attended lectures in chemistry by Thénard, physics by Gay-Lussac, zoölogy, and mineralogy, and took private instructions in mathematics. Through the recommendation of Thénard, he gained admittance to the private laboratory formerly occupied by Vauguelin, and continued his researches with fulminates. After he became acquainted he entered upon his work with great enthusiasm. To a friend he wrote,

> I thought I worked in Darmstadt. In Paris the daily routine is from seven in the morning to midnight, and I am happy * * * *.

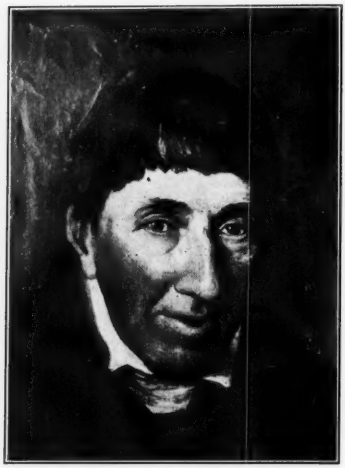
Even at this early time we meet with Liebig's interest in applied chemistry. He had improved the method of preparing a green mineral color. The yield as well as the quality was improved. In order to benefit by his discovery he sold the method to a chemical factory and entered into a royalty contract from which he expected a substantial return. This color was Paris green.

The lectures during the second term were conducted by Dulong and Biot. Liebig wrote,

> The industry of the French professor is to be praised, no one is thinking of vacation now. Easter is passed and I could not enjoy myself as I usually do. The lectures closed on Saturday as usual and began again on Monday.

He soon found that the grant was not sufficient to carry him through even the first semester. So we find him asking for further financial assistance from the Grand Duke. The Duke's Cabinet Secretary, Dr. Ernst C. F. A. Schleiermacher, appreciated Liebig; he recognized in him a young

* Florin = Gulden.



DR. H. C. ERNST. C. F. A. SCHLEIERMACHER, 1755–1844

From an oil painting by Heuss.

man of unusual ability and did everything in his power to assist him. It is probably due to his influence as well as the recommendations of Professor Kastner that the Grand Duke made the original grant and its later extensions. The records indicate that from May 24, 1822, when the original grant was made to March 25, 1824, a total of 2480 florins were made available.

Further evidence of the kindly offices of Professor Kastner are shown in his action in recommending to the faculty at Erlangen that Liebig be granted the degree of Doctor of Philosophy *in absentia*. In June Professor Kastner sent the diploma to the Grand Duke as evidence of the esteem in which Liebig was held by the faculty.

On July 28, 1823, Gay-Lussac read before the Academy a paper of Liebig's concerning a new acid. A letter of Liebig to his parents described the meeting of the Academy and the effect of the *memoire* upon the members.

* * * * * * * * * I mentioned (in a previous letter) that I had made an interesting discovery and that I transmitted a *memoire* to the French Royal Academy and now hurry to give you the details. I have discovered an acid which arises through the action of alcohol upon nitric acid; the combination of this acid with metal oxides constitutes silver fulminate and mercury fulminate and others, also I have discovered fulminating copper, fulminating iron, fulminating zinc and many others, substances about which the French chemists have been breaking their heads for a long time, and many analyses which acquaint us with the exact composition of these materials, in short, etc., etc. You will be able to read it later. My *memoire* was completed, Thénard read it through with me once more, and we went to the Academy. What caused me to wonder greatly was the fact that the first paper considered was my *memoire*. Because Thénard was president of the Academy he could not present it, and Gay-Lussac had the kindness to read it. I brought the new salts and preparations with me and exhibited them before the meeting. During the presenting of the paper, which required quite a long time, signs of approbation were evident and after its completion the members gave me unmistakable evidence of it. Mr. v. Humboldt, himself, the renowned traveler, came to me and conversed with me for almost an hour. Finally Gay-Lussac and—(undecipherable) were appointed *rapporteurs*, and will present their report to the Academy by Monday; that this will be favorable to me, I am sure. Next month it will appear in the *Annales de chimie*, and I will then send our gracious Lord and my honored Mr. Schleiermacher several copies. I believe, and I am convinced that it will please them.

Liebig continued his researches on these compounds and on December 15, 1823, presented another *memoire* to the Academy. The report on this is exceedingly favorable. It closed with the statement:

> There remain to be described and studied a large number of salts the existence of which were not even suspected before the discovery of Mr. Liebig. These various questions will be examined in a *memoire* with which the author is now occupying himself.
>
> The new view presented by this work leads us to expect much of the talent of its author * * * * * *.

The report is signed by MM. Gay-Lussac and Dulong.

Since the reading of Liebig's first paper before the Academy, Baron Alexander von Humboldt had taken an interest in him. He had written to the Grand Duke Ludwig highly recommending Liebig and suggesting that he be made a university professor. He wrote:

> * * * * * * * we have had the privilege of having among us one of your subjects, honored sir, who by the superiority of his talent, his extensive knowledge of chemistry, and the sagacity of his spirit has quickly attracted the attention of the Royal Institute of France; Doctor Liebig joins to these qualities of the mind a gentleness of character and an amenity of heart which is so seldom found among the savants of his age * * * * *. He will be a professor who will honor his country, and the gratitude for the sovereign who will deign to honor such distinguished talent will be shared by my fellows in the Academy, MM. Gay-Lussac, Thénard, Dulong, and Vauquelin * * * * *.

Liebig remained in Paris working with Gay-Lussac on the fulminates. On March 22nd he presented the result of this work in a *memoire* to the Academy. The esteem in which this youth of twenty-one years was held is evident from the various letters which have been quoted.

The Grand Duke was no doubt gratified that the youth whom he had so generously assisted had risen to such heights. In May 24th he appointed him *auserordentlicher* professor at the University of Giessen. A university professor at the age of twenty-one: a very unusual occurrence, especially for that time.

Throughout we have seen the outstanding ability and determination of Liebig carrying him to these heights. However, we must not lose sight of the men Kastner, Schleiermacher, and Humboldt, who, discerning these characteristics, devoted their energies to bring him to the attention of Ludwig, through whose beneficence Liebig was enabled to prepare himself for his life work.

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Liebig's Autograph Album.

THE OTHER OXIDES OF CARBON

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Students of chemistry soon learn in detail the chemistry of carbon dioxide and monoxide, though few know that other oxides exist. As early as 1873 Brodie obtained two oxides and proposed the theory that an entire homologous series of oxy-carbons existed. The preparation and properties of the definite oxides, carbon suboxide (C_3O_2), leuconic acid (C_5O_5), triquinoyl (C_6O_6), and mellitic anhydride ($C_{12}O_9$) are described. The indefinite oxides, such as graphitic acid, and those formed when oxygen and carbon unite, are described and their indefinite composition and colloidal nature are discussed.

. . . . . .

The high-school student of chemistry soon learns in detail the chemistry of carbon dioxide and monoxide and of their great scientific and industrial importance. However, even graduate students in chemistry are sometimes unaware of the existence of other oxides of carbon, which, though not as important as the first two, are more interesting chemically. The reason for this may be that textbooks do not usually contain this information. Some of the larger texts mention the existence of a third oxide, but on the whole the original literature must be consulted. In this paper are presented briefly the important and interesting chemistry of the carbon-oxygen compounds other than carbon dioxide and monoxide.

Historical

In 1873 Brodie (*1*) found that when carbon monoxide was subjected to the electric discharge, carbon dioxide and a red-brown solid were formed. The solid was shown upon analysis to consist of only carbon and oxygen, but samples from different experiments did not have the same composition. Brodie identified by analysis two oxides, C_4O_3 and C_5O_4. He suggested that a homologous series of oxy-carbons existed, of which the carbon atom might be regarded as the first member and succeeding members differed by the unit CO; precisely as a homologous series of hydrocarbons differ by the unit CH_2. Thus this series of oxy-carbons was analogous to the hydrocarbons of the acetylene series so that C_4O_3 corresponds to C_4H_6 or butyne, and C_5O_4 to C_5O_8 or pentyne. M. Berthelot (*2*) confirmed the work of Brodie and found that when the brown oxide was heated it decomposed to form carbon dioxide, carbon monoxide, and a new oxide $C_{16}O_6$ (or C_8O_3). Thus the series of oxy-carbons were formed by the reactions:

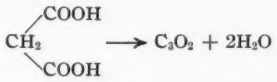
$$n\ CO \longrightarrow C_nO_n$$
$$C_nO_n \longrightarrow C_{n-1}O_{n-2} + CO_2$$

Carbon Suboxide, C_3O_2

In hopes of preparing a new class of compounds, Diels and Wolf (*3*) heated diethyl malonate with phosphorus pentoxide and obtained ethy-

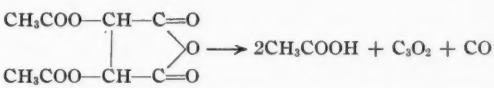
lene, water, and a gas with a highly pungent odor. An analysis and vapor-density determination showed the gas to have the formula C_3O_2. This compound they named carbon suboxide; though not without objections from Berthelot who insisted that the name carbon suboxide represented a whole series of compounds and no one member in particular. However, the name carbon suboxide has been accepted for this compound C_3O_2.

Carbon suboxide can be prepared from malonic acid and many of its derivatives (*4*) as the diethyl ester which was first used.



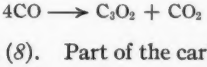
$$CH_2(COOH)_2 \longrightarrow C_3O_2 + 2H_2O$$

The best method of preparation (*5*) giving yields up to seventy-five per cent is the decomposition of diacetyl tartaric anhydride over a heated platinum filament according to the equation:



$$CH_3COO{-}CH{-}C{=}O \quad CH_3COO{-}CH{-}C{=}O \longrightarrow 2CH_3COOH + C_3O_2 + CO$$

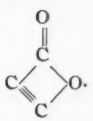
By passing carbon monoxide through an ozonizer the reaction



$$4CO \longrightarrow C_3O_2 + CO_2$$

takes place to a slight extent (*8*). Part of the carbon suboxide polymerizes to the red-brown solid observed by Brodie.

As carbon suboxide was formed from malonic acid by the loss of two molecules of water, Diels considered it to have the structure represented by the formula, O=C=C=C=O. He showed that carbon suboxide gave reactions similar to the class of compounds with a similar structure, the ketenes $\begin{matrix} R \\ R \end{matrix}\!\!>\!C{=}C{=}O$. Thus this formula is known as the diketene formula since both halves of the carbon suboxide molecule resemble the ketene grouping. Michael (*6*) thought that a cyclic structure might be possible, as



Neither structure has been proved, though the diketene structure of Diels is usually accepted as being correct.

Carbon suboxide is a gas at room temperature. It can be easily condensed to a colorless liquid boiling at + 7°C. and on further cooling it solidifies to large colorless crystals which melt at −111°C. Carbon suboxide has an unbearable odor, small amounts acting as a lachrymator while

higher concentrations attack the eyes, nose, and respiratory tract, giving a feeling of suffocation and nausea.

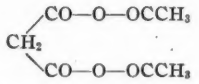
The gas burns in air forming carbon dioxide.

$$C_3O_2 + 2O_2 \longrightarrow 3CO_2$$

Carbon suboxide reacts with small molecules to give derivatives of malonic acid, thus behaving as an anhydride of malonic acid. With water, malonic acid is formed, with ammonia, malonamide, alcohols form esters of malonic acid.

$$O{=}C{=}C{=}C{=}O + 2H_2O \longrightarrow CH_2(COOH)_2$$
$$O{=}C{=}C{=}C{=}O + 2NH_3 \longrightarrow CH_2(CONH_2)_2$$

In liquid sulfur dioxide solution it reacts with organic acids, as formic and acetic acids, to form mixed anhydrides, as with acetic acid:

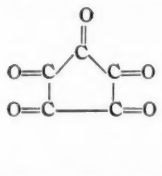


The highly unsaturated character of carbon suboxide causes it to polymerize very readily. At room temperature the liquid will polymerize in a day to give a solid, amorphous, dark red substance, completely soluble in water giving a red-brown solution. Above 37°C. the polymer loses carbon dioxide leaving a solid, containing less oxygen, which is but partially soluble in water. The polymer when heated strongly gives off carbon dioxide, carbon monoxide, and also reforms some carbon suboxide, leaving a residue which when heated to glowing does not form carbon but a carbon oxide very poor in oxygen. The polymer rapidly takes up water from the air and dissolves in water to give a colloidal solution of acid character which acts as a red-brown dye. The polymer has been given the formula C_6O_4 by Hartley (7) though this is but a guess.

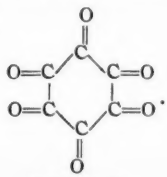
Carbon suboxide has been the subject of more experimental work than the other oxides so it is more often mentioned in textbooks and in special reviews (9).

Leuconic Acid, C_5O_5, and Triquinoyl, C_6O_6

These oxides will be considered together since both are formed in the same reaction and triquinoyl may be converted to leuconic acid. Both are cyclic oxides and might be more properly named cyclopentanepen-

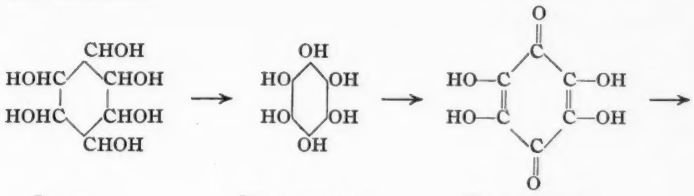


LEUCONIC ACID

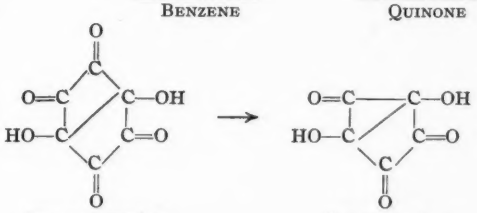


TRIQUINOYL

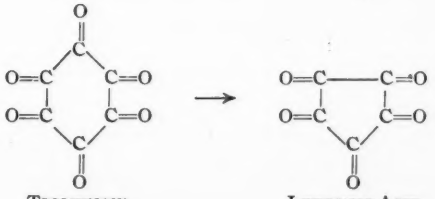
tanone for leuconic acid and cyclohexanehexanone for triquinoyl. Both oxides are hydrated; leuconic acid has four molecules of water associated with it while triquinoyl has eight. Both substances have been prepared by the oxidation of the cyclic alcohol, inosite. The very recent work of Gelormini and Artz (*10*) shows the sequence of reactions that takes place in this oxidation.



INOSITE HEXAHYDROXY-BENZENE TETRAHYDROXY-QUINONE



RHODIZONIC ACID CROCONIC ACID



TRIQUINOYL LEUCONIC ACID

Thus if any of the intermediate compounds can be prepared the oxides can be made by oxidation with nitric acid. When the sodium bisulfite addition compound with glyoxal, $(CHO{\cdot}NaHSO_3)_2$, is treated with sodium carbonate solution (*11*) there are immediately formed the blue-black crystals of the disodium salt of tetrahydroxyquinone, which when boiled with dilute hydrochloric acid or oxidized by the air according to the directions of Nietzki and Benckiser (*12*) will yield rhodizonic acid, triquinoyl, croconic acid, and leuconic acid.

When dry carbon monoxide gas is passed over molten potassium a compound called potassium carbonyl is formed (*13*). This compound has been assigned various formulas since the molecule must be some multi-

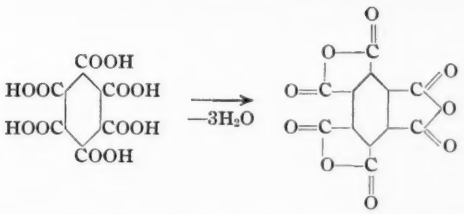
ple of the simple analytical formula, KCO. This compound, when freshly prepared, is a gray crystalline mass and is absolutely safe, but on standing in the air it takes on highly explosive properties. Nietzki and Benckiser showed that, when this compound is decomposed with dilute hydrochloric acid in the absence of air, hexahydroxybenzene is formed. This is an extremely interesting observation, since here the benzene nucleus has been built up from six separate carbon atoms. Thus the formula of potassium carbonyl is $K_6C_6O_6$, and it is the potassium salt of hexahydroxybenzene. As the oxidation chart on page 235 shows, hexahydroxybenzene can be oxidized to form triquinoyl and leuconic acid.

Leuconic acid is a solid which forms small colorless needles when crystallized from nitric acid. It has a sweet taste. It is very soluble in water, difficultly soluble in alcohol and insoluble in ether. The molecule is usually hydrated with five molecules of water but on drying at 100°C. a molecule of water is removed. When heated to above 100°C. it becomes yellow and reforms croconic acid, a reaction that also takes place upon boiling in solution with alkali carbonates. Leuconic acid on reduction yields croconic acid or hydrocroconic acid. When treated with hydroxylamine it forms the pentaoxime, upon which fact is based the proof of the five carbonyl groups.

Triquinoyl is also a solid which forms colorless microscopic crystals when crystallized from dilute nitric acid. It is practically insoluble in cold water, alcohol, or ether. The molecule is hydrated with eight molecules of water. In leuconic acid there are five molecules of water, equal to the number of carbonyl groups, therefore the water might be attached so that two hydroxyl groups are on each carbon atom, as $>C\langle^{OH}_{OH}$. Since it loses but one molecule of water on being heated to 100°C. and since the eight molecules of water in triquinoyl exceed the six carbonyl groups, it is unlikely that the water is attached in this manner, but is attached in the same way as the water of hydration in inorganic compounds. When triquinoyl is heated to 95°C. it melts, evolving carbon dioxide and water, leaving a residue which when treated with potassium hydroxide solution gives the potassium salt of croconic acid. Triquinoyl can be reduced, yielding rhodizonic acid with sulfurous acid and hexahydroxybenzene with stannous chloride.

Mellitic Anhydride, $C_{12}O_9$

Mellitic acid, or benzene hexacarboxylic acid, $C_6(COOH)_6$, is produced when dry pine charcoal is oxidized by an excess of concentrated nitric acid, giving a yield of 44% mellitic acid. By heating this acid with benzoyl or acetyl chloride water is removed and anhydride formation takes place (*14*).



The anhydride contains only carbon and oxygen, each being almost exactly 50% of the composition by weight.

Mellitic anhydride is a colorless solid and may be recrystallized from benzoyl chloride. It can be dried unchanged at 160°C. but when heated to temperatures over 320°C. it darkens and on further heating glows and finally burns with a sooty flame. It can be sublimed in a vacuum. It is soluble in the higher aromatic hydrocarbons, giving beautiful red solutions.

Its chemical properties are those of an acid anhydride. Although quite insoluble in cold water, it reacts with hot water to reform mellitic acid of high purity. In benzene solution dry ammonia converts it into a mixed amide-ammonium salt $C_6(CONH_2)_3(COONH_4)_3$ which is a colorless crystalline powder soluble in water. With alcohols a mixture of acid esters is formed.

Graphitic Acid

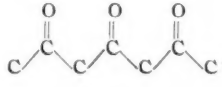
If graphite is oxidized with concentrated nitric acid and potassium chlorate, a yellow powder is obtained having the properties of an acid but of varying composition so that no definite formula can be assigned to it. Hulett and Nelson (*15*) showed that this acid could be dehydrated and that the relation of water to graphitic acid was exactly that of water to a colloidal substance which adsorbs water due to its large surface. Thus graphitic acid is a solid oxide of carbon with an exceptionally large surface which is covered with water held by the surface forces, just as silica gel holds large amounts of water. Correcting for the water held on the surface the analyses show a formula $C_{100}O_{27.3}$ to $C_{100}O_{38.4}$. The simple formula C_3O is somewhat lower than the results, while $C_{11}O_4$ is very close to the best data. However, no such simple formula represents the oxide molecule; it can only show the composition since this is a colloidal oxide and colloidal substances usually have large molecular weights as, for example, cellulose and the proteins.

The Carbon-Oxygen Complex Theory of Combustion

The combustion of carbon forms carbon monoxide and carbon dioxide. One theory of combustion holds that carbon dioxide is formed first and then reduced to carbon monoxide by the hot carbon present; while a second theory holds that the carbon monoxide forms first and is then burned

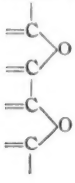
to carbon dioxide. The experiments of Rhead and Wheeler (*16*) show that both oxides are produced at the same time so that neither can be the initial product. They found that charcoal which had been heated strongly and evacuated, readily takes up oxygen which cannot be desorbed by a vacuum, as can be done with other adsorbed gases, such as hydrogen on charcoal. To remove the oxygen considerable heat and a vacuum are required; however the oxygen is not removed as such but combined with carbon in the form of carbon monoxide and carbon dioxide. From this Rhead and Wheeler concluded that oxygen unites with solid carbon to first form a complex compound of carbon and oxygen. To this they gave the indefinite formula, C_xO_y, since the carbon-oxygen ratio varies with the temperature, pressure, amount of surface exposed, and other factors. However there are actual valence forces acting between the atoms since the oxygen can be removed only as carbon monoxide or dioxide.

Lowry and Hulett (*17*) showed that oxygen taken up by charcoal was removed only as carbon monoxide and dioxide, while hydrogen could always be quantitatively recovered as such. They concluded that solid oxides of carbon of variable ratios were formed. These oxides must be stable at ordinary temperatures but decompose on heating, carbon dioxide predominating at lower temperatures and carbon monoxide at the higher temperatures. Langmuir (*18*) found that this solid oxide was not completely decomposed even when heated for a half hour at 2000°C. in the highest vacuum. From this he made the plausible guess that the oxygen atoms were chemically combined with the carbon atoms which formed the surface of his heated filament, as:

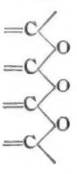


From adsorption experiments in solution, Shilov and his co-workers (*19*) conclude that the adsorptive power of active charcoal is due to three oxides, *A*, *B*, and *C*, which exist on the surface of the particles. Oxide *A* is formed in a vacuum from *B* and is stable under oxygen pressures up to 2 mm., *B* is stable under pressures higher than this and on heating changes to *C*. Their proposed structures for these oxides are:

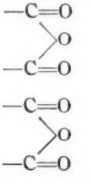
OXIDE *A*



OXIDE *B*



OXIDE *C*



Conclusions

In addition to carbon dioxide and monoxide, there are four other oxides that obey the law of definite proportions. These do not fall in the series of oxides proposed by Brodie, whose oxides do not meet the law of definite proportion. However, oxygen has a great tendency to combine with a carbon surface with the formation of a complex compound.

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(15) HULETT and NELSON, *Trans. Am. Electrochem. Soc.*, **37,** 103 (1920).
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(18) LANGMUIR, *ibid.*, **37,** 1154 (1915).
(19) SHILOV, SHATUNOVSKA, and CHMUTOV, *Z. physik. Chem.*, Abt. A, **149,** 211 (1930).

United States Civil-Service Examination for Junior Chemist. Applications for the open competitive examination for junior chemist must be on file with the U. S. Civil-Service Commission at Washington, D. C., not later than January 27, 1931. This examination is to fill vacancies in the Departmental Service or in the field. The entrance salary is $2000 a year.

Competitors will be rated on general chemistry and elementary physics, and on one or more of the following-named optional subjects: (1) advanced inorganic chemistry, (2) analytical chemistry, (3) organic chemistry, and (4) physical chemistry.

Applicants must show that they have been graduated with a bachelor's degree from a college or university of recognized standing, such degree requiring the completion of at least 118 credit hours, 30 credit hours of which must have been in chemistry.

Full information may be obtained from the United States Civil-Service Commission, Washington, D. C., or from the Secretary of the United States Civil-Service Board of Examiners at the post-office or custom house in any city.

EARLY PORTRAITS OF BENJAMIN SILLIMAN*

LYMAN C. NEWELL, BOSTON UNIVERSITY, BOSTON, MASSACHUSETTS

Of the five known early portraits of Benjamin Silliman, Sr., two, recently found, are described in this article.

. . . . . .

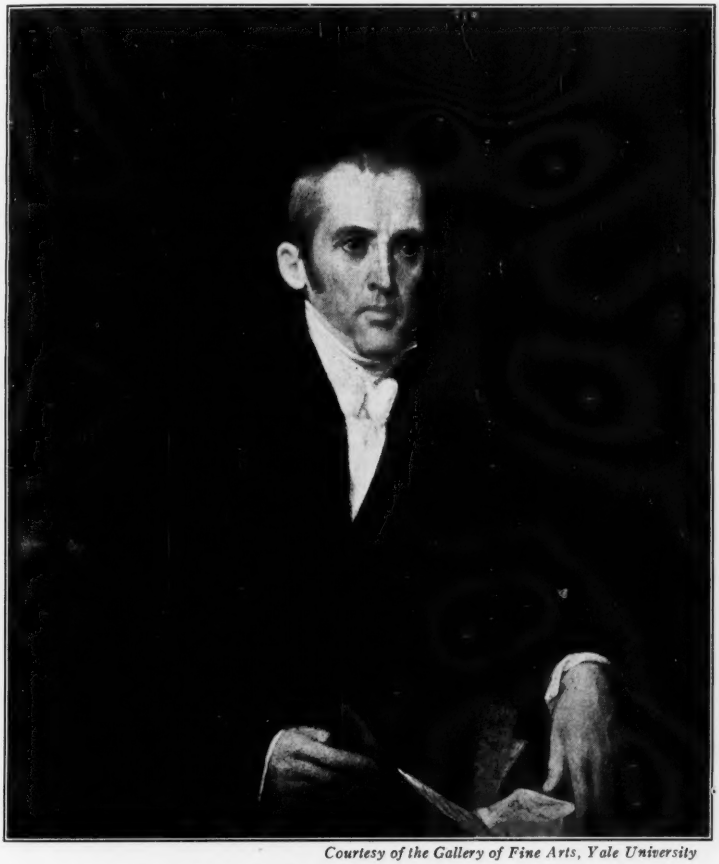
Benjamin Silliman was a commanding figure in American science during the first half of the nineteenth century. From his appointment as professor of chemistry at Yale College in 1802 till his retirement in 1853 he spent an exceedingly active life as a teacher, public lecturer, writer, and editor. His field was not limited to chemistry. He was proficient and productive in geology, mineralogy, and pharmacy. As a writer and editor he will always be remembered for his *American Journal of Science*, first known as *Silliman's Journal*, which was established in 1818, continued unselfishly throughout his life, and passed along to efficient successors who still foster its regular appearance. The public lectures delivered by Silliman were attended by thousands of intelligent persons. For many years courses in chemistry and in geology were given in the large cities in the United States.

BENJAMIN SILLIMAN—FROM A PAINTING BY WILLARD, 1835

At this time Silliman was giving his first course of public lectures in Boston.

Through his lectures and his journal, extensive travel in this country and Europe, conspicuous service as an expert in industrial projects, and his long service as a teacher of chemistry, Silliman became widely known and highly respected. We would naturally conclude that many early portraits

* Read before the Division of History of Chemistry at the 80th meeting of the American Chemical Society, Cincinnati, Ohio, September 8 to 12, 1930.



Courtesy of the Gallery of Fine Arts, Yale University

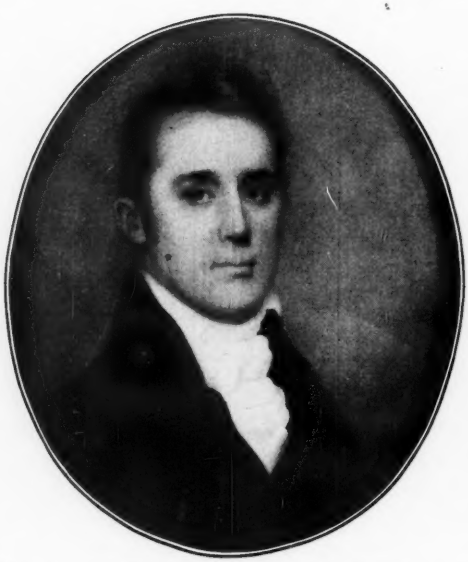
PORTRAIT OF BENJAMIN SILLIMAN PAINTED BY FLAGG IN 1832–33
At this time Silliman was 53 years old.

of such a well-known man would have been made. Such, however, does not seem to have been the case.

Until recently the earliest known portrait was the one painted by Willard when Silliman was lecturing in Boston in 1835. In his diary we find this entry:

> March 7—Called on Willard the painter, who wished to paint my portrait, and I am to sit for him on Monday, March 9th.

The Willard painting (see illustration on page 240) is well known through excellent steel engravings. It shows Silliman in the characteristic



MINIATURE OF BENJAMIN SILLIMAN MADE BY ROGERS IN 1818

At this time Silliman was 39 years old.

costume of that period—stiff collar and ample neckcloth. The face is that of a young man, though Silliman at this time was fifty-six years old.

I found an engraving of the Willard painting in Boston about thirty years ago. Subsequently, reproductions of portraits of a later date were also found and added to a growing collection of portraits of famous American chemists. But it seemed rather unusual that portraits of an earlier date than the Willard painting could not be found. Such a conspicuous public man as Silliman, I argued, must have been painted long before he was fifty-six years old. So I began to look for the early portraits of Silliman. Diligent search and inquiry in this country and in Europe were not rewarded until a few months ago.

Silliman not only kept a dairy, as implied above, but he also made and saved notes and memoranda about himself and his work. One of his descendants, still living (1930) in New Haven, found a paper containing a list of portraits, busts, etc., in Silliman's own handwriting. Here is a list of the portraits:

A pencil sketch by Tisdale of Lebanon, 1804–5, retained by the artist.

A miniature by Tisdale, winter of 1805—I believe it is at my brother's (G. S. Silliman) in Brooklyn.

Another picture painted at the request of John Griscom and probably in possession of the family.

Portrait by Flagg, 1832–1833, sent to Dr. Mantell of England.

A large miniature by Rogers in New York, in 1818.

Only two of these five early portraits are available at present—the Flagg painting and the Rogers miniature. Through the kindness and

help of a graduate* of Boston University, I have been fortunate in obtaining photographs of both of these.

The Flagg painting (see illustration on page 241) was sent to a Dr. Mantell in England, bequeathed by him to a descendant in New Zealand, and recently acquired by the Gallery of Fine Arts of Yale University. It is only a few years earlier than the Willard painting though it depicts Silliman as an older man—perhaps more nearly lifelike than the Willard painting.

The Rogers miniature (see illustration on page 242) is a gem. It belongs to a distinctly earlier period. Its whole aspect is different from any other portrait of Silliman. I compared the costume with miniatures of that period and found that it agrees perfectly. The date, 1818, is significant. This is the year Silliman started the *American Journal of Science*. We are fortunate in possessing a portrait of him at this time of life and Yale University is likewise fortunate in acquiring the painting by Flagg.

* Warren R. Reid, Boston University, 1929, a graduate student in the department of history at Yale under the Professor Augustus Howe Buck Fund of Boston University.

Smelly Gas Made Standard as Mine Warning. A disagreeable odor, resembling that of decayed cabbage, rancid butter, or banana oil, will be used to warn workers in metal mines of fire. It will be shot to threatened miners at the rate of thousands of feet a minute mixed with oncoming fresh air in the ventilating shafts.

Recognizing this method of warning as the most effective, the American Standards Association has made it a part of the American Standard code for fire fighting in metal mines. As a result of its becoming a part of the national code, the method will undoubtedly be employed in many mines.

In addition to the use of a disagreeable odor as a warning signal, the standard also provides that in mines equipped with electric lights the engineers shall also flash all electric lights nine times in three series of three flashes each. Since trouble may develop in the electrical system, however, the odor signal is considered to be the most reliable warning.

While pleasant odors have been experimented with, disagreeable odors have been found preferable because of the more positive effect which they exert. The U. S. Bureau of Mines, which played an important part in the establishment of the standard, found that when miners smell the disagreeable odors used, they instinctively desire to obtain pure air at once. If the miners are unable to reach the surface for any reason, however, it has been found that they are able to tolerate the odors without much discomfort.

The odors are injected in liquid form into the compressed air line supplying air to the mines. Little liquid is required, the odors being detectable at concentrations of only a few parts per million parts of air. At higher concentration the odor becomes strong enough to make the warning positive. None of the odors can exert any harmful influence even if inhaled for a long period. Some of the substances used are known technically as butyl mercaptan, ethyl mercaptan, butyric acid, and amyl acetate.—*Science Service*

A SCIENCE FAIR

GEORGE N. CAROTHERS, SENIOR HIGH SCHOOL, ROSWELL, NEW MEXICO

Students of botany, zoölogy, physics, and chemistry took part in the Science Fair herein described. The Fair, consisting of fifty-one exhibits, was open two days and evenings. Students were given extra credit for completed exhibits. Manufacturing concerns and local patrons were very liberal with material and assistance.

. . . . . .

For several years our science club had discussed the possibilities of holding a science exhibit for the public. The opportune time arrived when the parents and teachers association asked the science department to take charge of their program for May.

The Science Fair was planned and executed under the joint direction of the three science teachers in the school: Miss Winifred Crile (zoölogy and botany), Mr. Paul H. Deaton (physics), and the author (chemistry). Any member of a science class was eligible to participate. The exhibits were selected by the students from a list submitted by the teachers. Material and information were collected, school stationery being used for all correspondence. Merchandise was borrowed from local firms and the individual student held responsible for it. The exhibits were planned to show (1) the evolution of a product, (2) the process from the raw material to the finished product, or (3) some scientific fact.

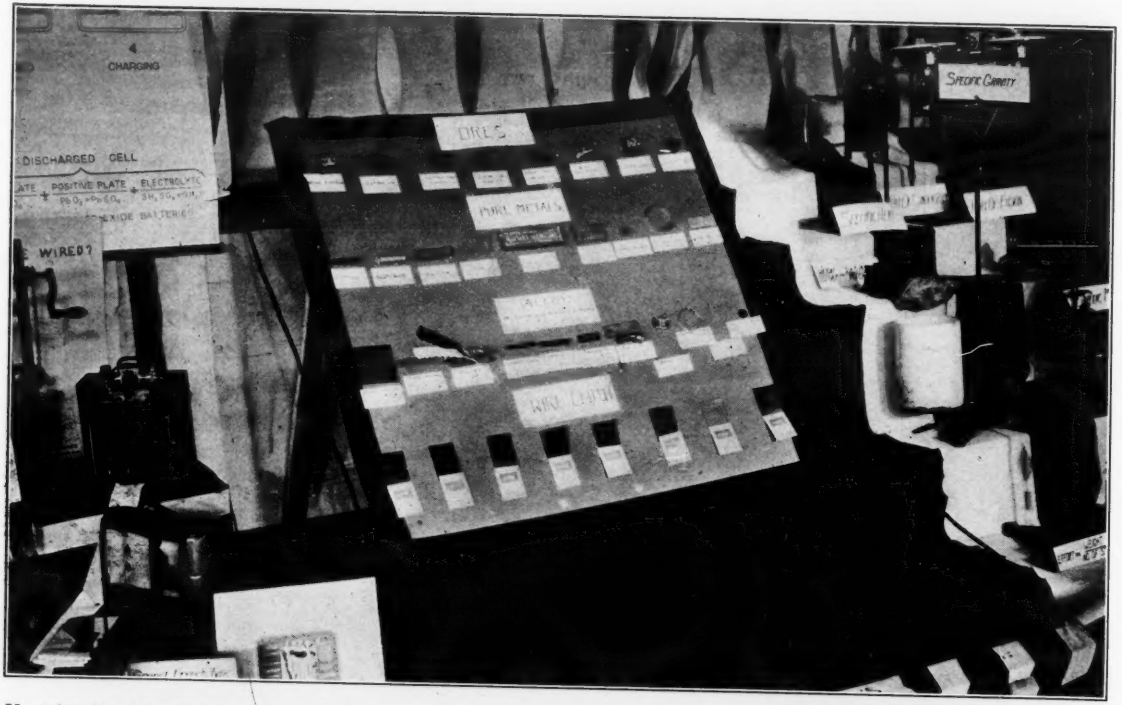
The Science Fair was held in the school auditorium, a room thirty-four by sixty-four feet. Booths were erected by the students and arranged around the walls. The color scheme for decoration was uniform; red and white, the school colors, were used. Each student furnished the crêpe paper, at a cost of about thirty cents, for his own booth. In addition, a canopy ceiling formed of red and white crêpe paper strips, an enormous globe (constructed by the physics students) covered with hundreds of small bits of mirrors and hung in the center of the hall, and effective arrangement of lights made a very attractive setting for the exhibit.

The local papers coöperated with the club in giving publicity to the plans and outstanding features of the Science Fair. A portable victrola and an amplifier loaned by a local music firm added a pleasing atmosphere.

May 1st and 2nd, Thursday and Friday, were the dates of the Science Fair. The doors were open from eight-thirty in the morning until ten in the evening. Each exhibitor was required to be on duty each evening from seven until nine at which time the largest numbers were in attendance. This gave an opportunity for the pupils to meet the public and also for the public to ask questions of the exhibitors.

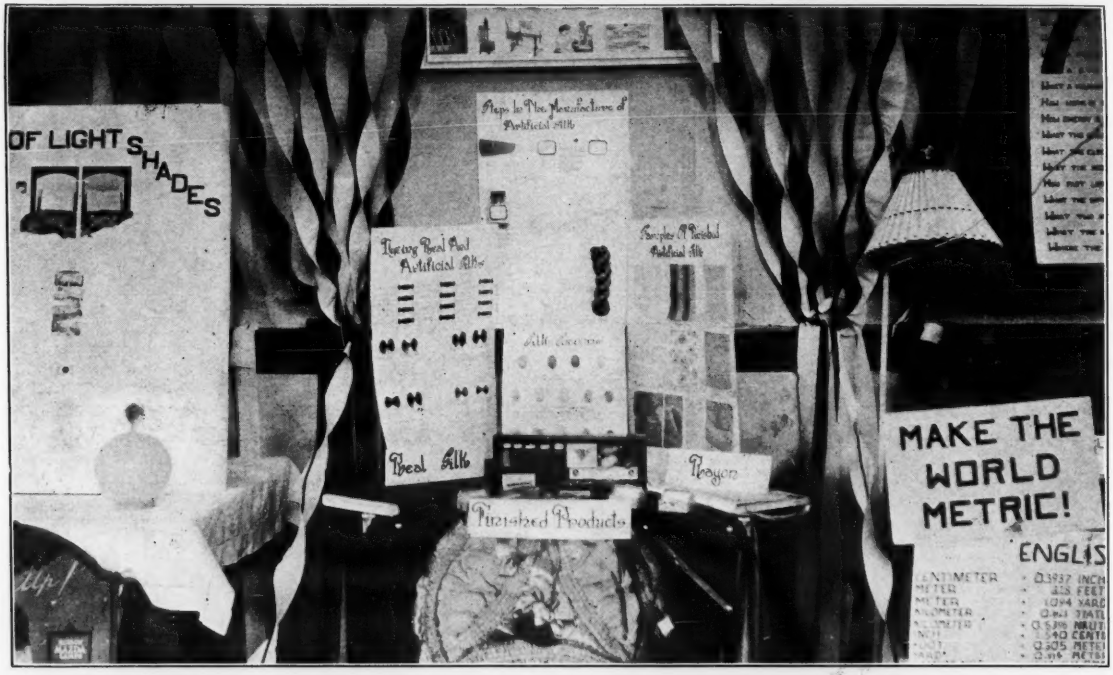
In order to preserve a permanent record of the exhibit, pictures of the outstanding booths were taken. We will now make a tour of the hall and see some of the exhibits.

From the stage we get a general view of the auditorium in day time. The exhibit center front is that of "Six Types of Bridges." A road-way, mirrors under the bridges, toy automobiles, a detour, a road camp, and road signs bearing New Mexico insignia all contribute to the realistic appearance of this exhibit.



Upon leaving the stage we come first to the booth displaying the inward parts of the various kinds of electrical cells and batteries. Next we see, neatly mounted and labeled, an exhibit on ores, pure metals, and alloys. An effective display of physical apparatus adjoins it.

Next we see, neatly mounted and labeled, an exhibit on ores, pure metals, and alloys. An effective display of physical apparatus adjoins it.



Our attention is next attracted to a neatly arranged booth exhibiting rayon and real silk. The various steps in the manufacturing processes of these materials are shown, the former consisting of samples of spruce wood to the woven cloth, and the latter of silkworm eggs to a spool of thread. To the right of this booth we see an exhibit on the metric system and to the left, one displaying the various types of light shades.

The two exhibits we now approach are of local interest. In the foreground of the oil exhibit is a working miniature model of a derrick and oil rig; in the center may be seen an elaborate display of oil products and a distillation apparatus to demonstrate how the above products are obtained by fractional distillation. To the right, the exhibit on southwestern life includes specimens of cacti, prairie dogs, horned toads, and lizards.

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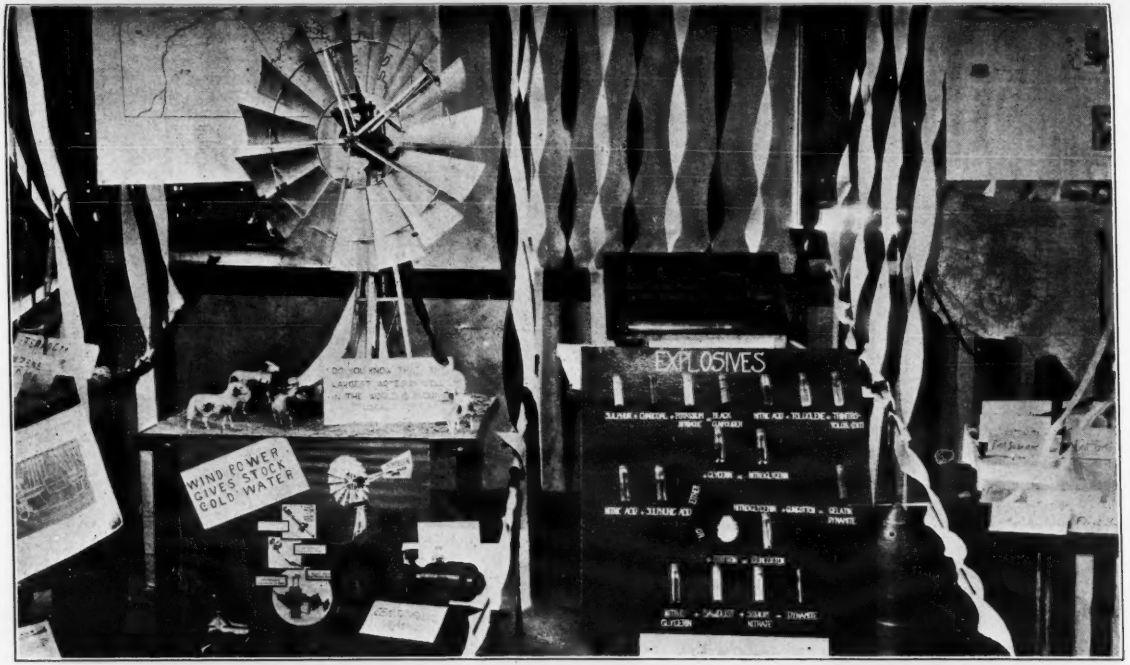

The model by-product coke oven you see on the extreme left was operated in the laboratory, by its builder, producing coke and other decomposition products. Two boys from ranches arranged the artesian well exhibit. These wells make our section of New Mexico a veritable oasis. And the explosives exhibit which you see next was worked up by a boy in the local battery of the National Guards. On the extreme right may be seen a display showing the geographical location in the U. S. of all the more important inventions.

Continuing our tour, we come next to the exhibit on cane and sirup, the chart behind it showing the steps of cotton manufacture from the boll to the thread and cloth; to the right and in the center, is a very neat display showing the methods for making Indian jewelry. Back of this is shown the process of electroplating. On the extreme right may be seen the many products of a grain of corn.

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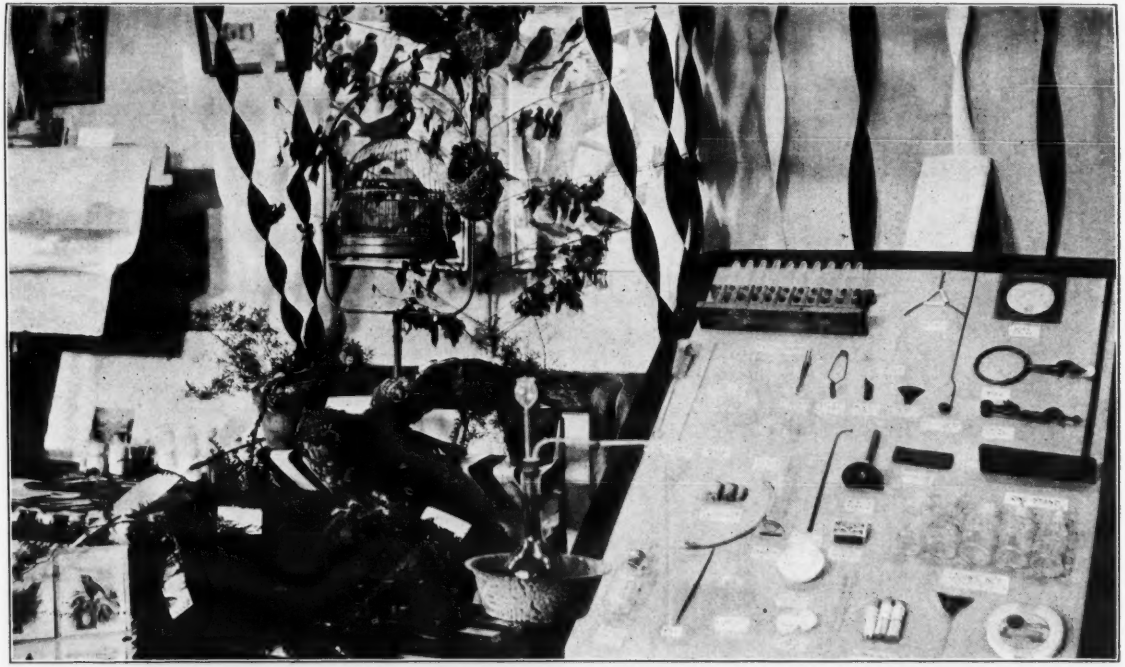
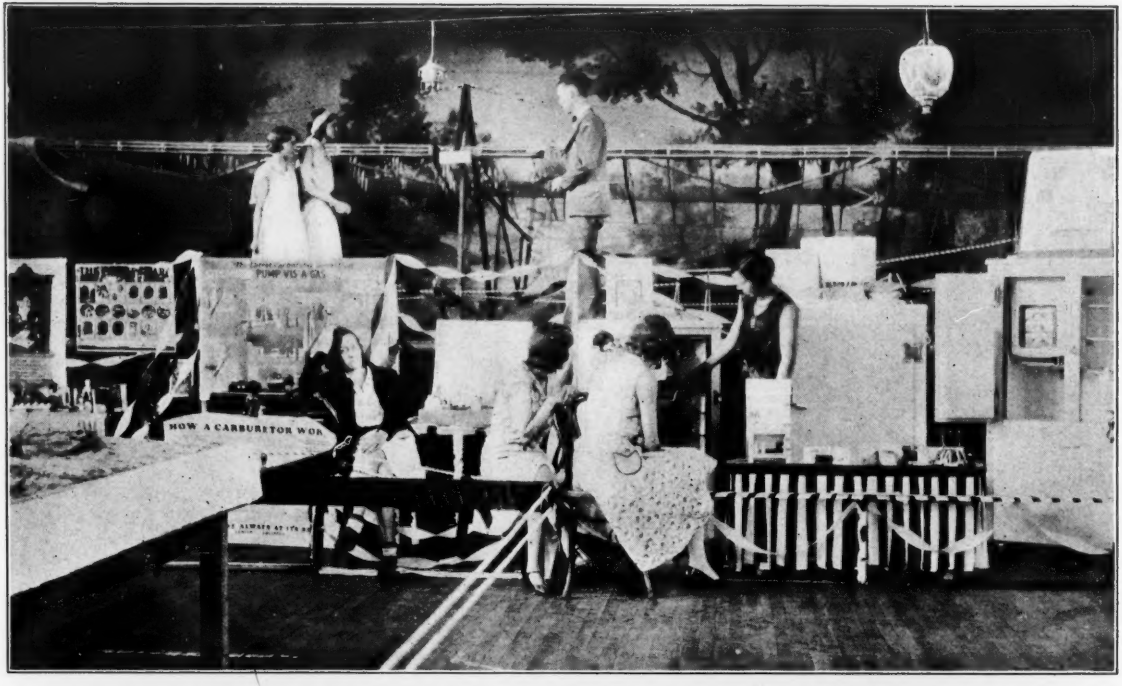


The booth to the left on paints and pigments took a practical angle when the youthful artist demonstrated how these could be put on canvas. The bowery effect of the next booth shows a student's love of nature at first hand. Here we have real birds and their homes. The exhibit adjoining might appropriately be called "Why Students Fail," for it consists of a complete set of apparatus, plainly labeled, found in a chemistry desk.



As we pass in front of the stage we learn from the common foods exhibit that even Coca Cola has calories in it. The models of a carburetor, of a washing machine, and of the modern electrical refrigerators are all instructive. On the stage may be seen a glider under construction. It has a forty-foot wing spread and when it is completed, the boys expect to fly it.

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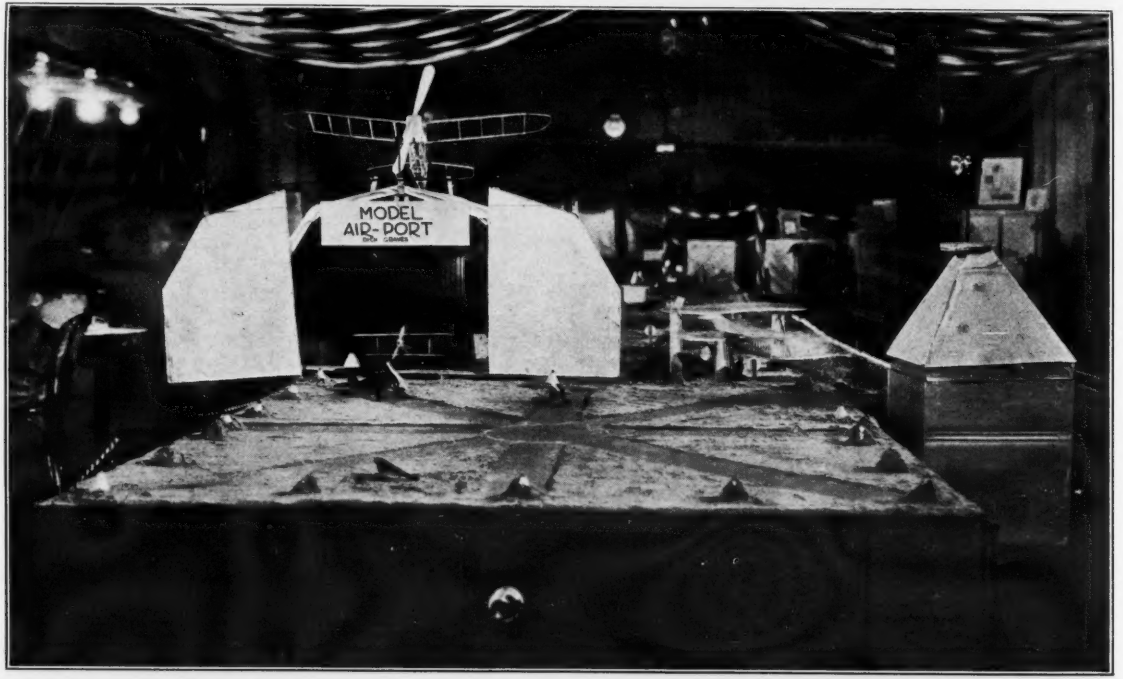

Before we leave we must visit the model airport. The modern local airport no doubt served as an inspiration for the exact reproduction of the port. The small field lights outline the field. The box at the right contains a small motor that controls the beacon light which rotates. The model planes are suspended from the ceiling to give the appearance of planes in the air about to land.

A complete list of the exhibits follows:

1. Ores, Pure Metals, and Alloys.
2. Batteries and Insulation.
3. One Cell Organisms.
4. Physics Apparatus.
5. Cement.
6. Breakfast Table of 1930.
7. Blue Prints.
8. Silk and Rayon.
9. Metric System.
10. Types of Light Shades.
11. Telephone.
12. Telegraph.
13. Electrical Fuses.
14. Wheat to Flour.
15. Glass.
16. Silver-Smithing.
17. Southwestern Life.
18. Potash.
19. Oil Industry.
20. Map of Inventions.
21. Explosives.
22. Windmills.
23. Corn Products.
24. Common Foods.
25. Electroplating.
26. Cotton.
27. The Uses of Cane.
28. Reflection of Light.
29. Chemistry Laboratory Desk Equipment.
30. Birds and Their Homes.
31. Paints and Pigments.
32. Rubber.
33. The Modern Banana.
34. Electric Clock.
35. Mechanical Toys.
36. Plant Parts.
37. Electric Signs.
38. Steam Engines.
39. Electric Irons.
40. Marine Life.
41. Writing Materials.
42. Development of Transportation.
43. Graf Zeppelin.
44. Refrigeration.
45. Six Types of Bridges.
46. Model Airport.
47. Glider.
48. Evolution of the Washing Machine.
49. Model Airplanes.
50. Carburetors.
51. By-Product Coke Oven.

According to the register, over a thousand persons attended the Fair. The most popular booths determined by the votes of the registrants, in the order of their popularity, were: (1) Types of Bridges, (2) Air Port, (3) Glider, and (4) Southwestern Life.

Since the work connected with the various exhibits differed widely, it seemed worthwhile to evaluate them. Every booth in the Fair was given a base grade of seventy per cent. To make a perfect score one would have to make thirty per cent additional. The ten following items, worth three per cent each, were used: the idea, amount of work, originality of idea, artistic merit, amount of decoration on the booth, clearness of explanation, effectiveness of display, value of instruction to the individual, instruction to the public, public notice. Grades were given out to the individuals as are examination grades. The grades ranged in value from seventy-four to ninety-seven per cent.

Realizing that often the enthusiasm of doing a thing will carry one into a project but not to completion, a rule was made that each student who successfully completed a project should receive an additional five per cent on his last six weeks grade. To successfully complete a project meant to dismantle the booth and properly return all material. This additional credit insured coöperation.

The exhibitors were allowed to keep any material they wanted. The remainder was kept as valuable material for classwork demonstrations. Great care was taken to see that all borrowed articles were returned. The hearty coöperation of local firms in lending articles was essential to the success of the Fair. However, no firm's name was displayed at the exhibit. A notice thanking all who had assisted, but without mentioning the names of the firms, was inserted in the local papers after the Science Fair closed.

The Fair was not commercialized and no admittance fee was charged. However, there was some expense connected with the decorations which had to be met. This was done by selling pop-corn and soft drinks, donated by local firms.

The success of this Fair has set us to planning for another one in about two years with a complete new list of exhibits. The Science Fair fully qualified as an educational project, for it enabled the exhibitors to learn from books, people, and things.

Acknowledgment

In addition to personal help and information obtained by attending Professor J. O. Frank's classes at the University of Colorado, I am indebted to the sources listed below for material and inspiration that made this project possible.

1. WOODRING, OAKES, and BROWN, "Enriched Teaching of Science in the High School," Bureau of Publications, Teachers' College, Columbia University, New York City, **1928.**

2. "What a Chemistry Club Can Do," J. CHEM. EDUC., **5,** 1335–9 (Oct., 1928).

3. "Commercial Material for Science Classes," *ibid.*, **5,** 1350–1 (Oct., 1928).

4. BELL, "A Chemistry Exhibit," *ibid.*, **5,** 280–90 (Mar., 1928).

5. FRANK, "Teaching First-Year Chemistry," J. O. Frank, Oshkosh, Wisconsin, **1926.**

United States Civil-Service Examination for Inspector, Bureau of Industrial Alcohol. Applications for the open competitive examination for inspector, Bureau of Industrial Alcohol, must be on file with the United States Civil-Service Commission at Washington, D. C., not later than February 4, 1931. This examination is to fill vacancies in the field at entrance salary of $2600 a year.

Competitors will not be required to report for written examination at any place, but will be rated on their education, experience, and fitness.

Applicants must show (1) graduation from a college or university of recognized standing, with major work in chemistry or physics, and two years of suitable experience, additional experience may be substituted for the college education up to three years; (2) graduation from a recognized school of pharmacy, or registration as a pharmacist, and in addition, three years of suitable experience as a pharmacist; or (3) at least three years' experience as federal, state, county, or municipal government inspector of chemical plants, distilleries, breweries, wineries, or pharmacies.

Full information may be obtained from the United States Civil-Service Commission, Washington, D. C., or from the Secretary of the United States Civil-Service Board of Examiners at the post-office or customhouse in any city.

HOW TIMES HAVE CHANGED! A PLAYLET IN TWO ACTS*

LOUIS C. JORDY,** DREW UNIVERSITY, MADISON, NEW JERSEY

The aim of the playlet is to contrast the attitude of the general public toward the scientist today, as compared with three centuries ago. Act I, synthesized from parts of Ben Jonson's longer play, "The Alchemist" (1610), shows how the follower of the Black Art was able, through a glib display of high-sounding and mystic language, to command respect, even reverence, for himself and his profession, though engaging in shameless trickery for his own personal benefit. Act II portrays the modern chemist, carrying out laborious researches in pure science without thought of personal gain, but looked upon as a sort of crack-brained visionary, who might better be employed in something really useful—using that term as defined by a self-made millionaire juggler of finances.

. . . . . .

Dramatis Personae

Act I: SIR EPICURE MAMMON, a Knight, client of SUBTLE.
PERTINAX SURLY, a sceptical friend of MAMMON.
SUBTLE, the Alchemist.
FACE, his laboratory assistant.
ANANIAS, another of SUBTLE'S dupes.

Act II: BEN Z. DEAN, a modern research chemist.
RAY D. YUMM, his laboratory assistant.
FEWES L. OYLE, a millionnaire client of DEAN.
ETHEL MUSTARD OYLE, his wife.

Argument

(*After the manner of the ancients*)

H erein is set forth, in acrostic style,
O ur aim, a pleasant hour to beguile:
W ith contrast of the old time and the new

T he status of our Science to review.
I n rare Ben Jonson's time may'st see our Art
M isused by many an ignorant upstart,
E mploying grandiose speech and mummeries
S catter-brained dupes and credulous fools to fleece;

* Presented by Alpha Chi Sigma and Pi Delta Nu at a joint public meeting, Syracuse University, Feb. 27, 1929.

** The author can claim originality only for the "Argument" and for Act II of this play. Act I is pieced together from portions of Scene I, Act II of Ben Jonson's famous play, "The Alchemist," first produced in 1610. To this the interested reader is referred for a detailed picture of some of the practices indulged in at that time in the name of chemistry. It will be observed that it is possible to reduce the number of characters required for Act I, as well as the length of the performance, by leaving out Mammon and Surly altogether and by starting the action with the approach of Ananias to the laboratory.

H owbeit, spite of quackery and deceit,
A we, faith, respect for Alchemy we meet.
V ast is the difference we see today:
E ach trace of trickery hath been purged away;

C hemists, disdaining riches or applause,
H ope only to learn more of Nature's laws.
A nd how is altruism like this repaid?—
N ay, gentles, wait until our play is played.
'G inneth Act I three centuries agone;
E ndeth the second now, in the fourth's dawn:
D raw now the curtain; let the play go on!

Act I

TIME: *A. D. 1610. Interior of* SUBTLE'S *laboratory, equipped with all sorts of fantastic apparatus, cryptic charts, stuffed animals, and other weird properties of the Alchemist of the day. As the curtain rises,* MAMMON *and* SURLY *enter from one side.*

MAMMON: Come on, sir. Now you set your foot on shore
In *Novo Orbe;* here's the rich Peru:
And there within, sir, are the golden mines,
Great Solomon's Ophir! He was sailing to't
Three years, but we have reached it in ten months.
This is the day wherein, to all my friends,
I will pronounce the happy word, *be rich;*
This day you shall be spectatissimi.
And unto thee I speak it first, *be rich.*
Where is my Subtle, there? Within, ho!

FACE: (*within*) Sir, he'll come to you by and by.

(*Enter* SUBTLE)

MAMMON: Good morrow, father.

SUBTLE: Gentle son, good morrow,
And to your friend there. What is he, is with you?

MAMMON: An heretic, that I did bring along
In hope, sir, to convert him.

SUBTLE: Son, I doubt
That you are covetous, that thus you meet your time
In the just point; prevent your day at morning.
This argues something worthy of a fear
Of importune and carnal appetite.
Take heed you do not cause the blessing leave you,
With your ungoverned haste. I should be sorry
To see my labors, now even at perfection,

Got by long watching and large patience,
Not prosper where my love and zeal hath placed them.
If you, my son, should now prevaricate,
And to your own particular lusts employ
So great and catholic a bliss, be sure
A curse will follow, yea, and overtake
Your subtle and most secret ways.

MAMMON: I know, sir;
You shall not need to fear me; I but come
To have you confute this gentleman

SURLY: Who is,
Indeed, sir, somewhat costive of belief
Toward your Stone; would not be gulled.

SUBTLE: Well, son,
All that I can convince him in, is this,
The work is done, bright Sol is in his robe.
We have a medicine of the triple soul,
The glorified spirit. Thanks be to heaven,
And make us worthy of it! Ulen Spiegel!

FACE: (*within*) Anon, sir.

SUBTLE: Look well to the register.
And let your heat still lessen by degrees,
To the aludels.

FACE: (*within*) Yes, sir.

SUBTLE: Did you look
O' the bolt's head yet?

FACE: (*within*) Which? on D, sir?

SUBTLE: Ay;
What's the complexion?

FACE: (*within*) Whitish.

SUBTLE: Infuse vinegar,
To draw his volatile substance and his tincture:
And let the water in glass E be filtered,
And put into the gripe's egg. Lute him well;
And leave him closed in balneo.

FACE: (*within*) I will, sir.

SURLY: What a brave language here is! Next to canting.
(*Enter* FACE.)

SUBTLE: How now!

FACE: Sir, please you,
Shall I not change the filter?

SUBTLE: Marry, yes;
And bring me the complexion of glass B. (*Exit* FACE.)

I mean to tinct C in sand-heat tomorrow,
And give him imbibition.

MAMMON: Of white oil?

SUBTLE: No, sir, of red. F is come over the helm too,
I thank my maker, in St. Mary's bath,
And shows *lac virginis*. Blessed be heaven!
I sent you of his faeces there calcined;
Out of that calx, I have won the salt of mercury

MAMMON: By pouring on your rectified water?

SUBTLE: Yes, and reverberating in Athanor.

(*Re-enter* FACE.)

How now! What colour says it?

FACE: The ground black, sir.

MAMMON: That's your crow's head.

SURLY: Your cock's-comb's, is it not?

SUBTLE: No, 'tis not perfect. Would it were the crow!
That work *wants* something.

SURLY: O, I looked for this,
The hay's a-pitching.

SUBTLE: Are you sure you loosed them
In their own menstrue?

FACE: Yes, sir, and then married them.
And put them in a bolt's-head nipped to digestion,
According as you bade me, when I set
The liquor of Mars to circulation
In the same heat.

SUBTLE: The process then was right.

FACE: Yes, by the token, sir, the retort brake,
And what was saved was put into the pellican,
And signed with Hermes' seal.

SUBTLE: I think 'twas so.
We should have a new amalgama.

SURLY: (*Aside*) O, this ferret
Is rank as any polecat.

SUBTLE: But I care not;
Let him e'en die; we have enough beside,
In embrion. H has his white shirt on?

FACE: Yes sir.
He's ripe for inceration, he stands warm,
In his ash-fire. I would not you should let
Any die now, if I might counsel, sir,
For luck's sake to the rest: it is not good.

MAMMON: He says right.

SURLY: (*Aside*) Ah, are you bolted?
FACE: Nay, I know't, sir,
I have seen the ill fortune. What is some three ounces
Of fresh materials?
MAMMON: Is't no more?
FACE: No more, sir,
Of gold, t'amalgame with some six of mercury.
MAMMON: Away, here's money. What will serve?
FACE: Ask *him*, sir.
MAMMON: How much?
SUBTLE: Give him nine pound; you may give him ten.
SURLY: Yes, twenty, and be cozened, do!
MAMMON: There 'tis. (*Gives* FACE *the money. Exit* FACE.)
When do you make projection?
SUBTLE: Son, be not hasty, I exalt our med'cine
By hanging him *in balneo vaporoso*.
And giving him solution; then congeal him;
And then dissolve him; then again congeal him;
For look, how oft I iterate the work,
So many times I add unto his virtue.
As if at first one ounce convert a hundred,
After his second loose, he'll turn a thousand;
His third solution, ten; his fourth, a hundred;
After his fifth, a thousand thousand ounces
Of any imperfect metal, into pure
Silver or gold, in all examinations,
As good as any of the natural mine.
Get you your stuff here against afternoon,
Your brass, your pewter, and your andirons.
MAMMON: Not those of iron?
SUBTLE: Yes, you may bring them, too;
We'll change all metals.
SURLY: I believe you in that.
MAMMON: Then may I send my spits?
SUBTLE: Yes, and your racks.
SURLY: And dripping-pans, and pot-hangers, and hooks?
Shall he not?
SUBTLE: If he please.
SURLY: —To be an ass!
SUBTLE: How, sir!
MAMMON: This gentleman you must bear withal:
I told you he had no faith.
SURLY: And little hope, sir;

But much less charity, should I gull myself.

SUBTLE: Why, what have you observed, sir, in our art,
Seems so impossible?

SURLY: But your whole work, no more.
That you should hatch gold in a furnace, sir,
As they do eggs in Egypt!

SUBTLE: Sir, do you believe
That eggs are hatched so?

SURLY: If I should?

SUBTLE: Why, I think that the greater miracle.
No egg but differs from a chicken more
Than metals in themselves.

SURLY: That cannot be.
The egg's ordained by nature to that end,
And is a chicken *in potentia.*

SUBTLE: The same we say of lead and other metals,
Which would be gold if they had time.

MAMMON: And that
Our art doth further.

SUBTLE: Ay, for 'twere absurd
To think that nature in the earth bred gold
Perfect in the instant: something went before
There must be remote matter.

SURLY: Ay, what is that?

SUBTLE: Marry, we say—

MAMMON: Ay, now it heats: stand, father,
Pound him to dust.

SUBTLE: It is, of the one part,
A humid exhalation, which we call
Materia liquida, or the unctuous water;
On the one part, a certain crass and viscous
Portion of earth; both which, concorporate,
Do make the elementary matter of gold;
Which is not yet *propria materia,*
But common to all metals and all stones;
For, where it is forsaken of that moisture,
And hath more dryness, it becomes a stone:
Where it retains more of the humid fatness,
It turns to sulfur, or to quicksilver,
Who are the parents of all other metals.
Nor can this remote matter suddenly
Progress so from extreme unto extreme,
As to grow gold, and leap o'er all the means.

Nature doth first beget the imperfect, then
Proceeds she to the perfect. Of that airy
And oily water, *mercury* is engendered;
Sulfur of the fat and earthy part. These two
Make the rest ductile, malleable, extensive.
And even in gold they are; for we do find
Seeds of them by our fire, and gold in them
And can produce the species of each metal
More perfect thence, than nature doth in earth.

MAMMON: Well said, father!
Nay, if he take you in hand, sir, with an argument,
He'll bray you in a mortar.

SURLY: Pray you, sir, stay.
Rather than I'll be brayed, sir, I'll believe
That Alchemy is a pretty kind of game,
Somewhat like tricks o' the cards, to cheat a man
With charming.

SUBTLE: Sir?

SURLY: What else are all your terms,
Whereon no one of your writers 'grees with other?
Of your elixir, your *lac virginis*,
Your stone, your med'cine, and your chrysosperme,
Your sal, your sulfur, and your mercury,
Your oil of height, your tree of life, your blood,
Your marchesite, your tutie, your magnesia,
Your toad, your crow, your dragon, and your panther;
Your sun, your moon, your firmament, your adrop,
Your lato, azoch, zernich, chibrit, heautarit,
Hair o' the head, burnt clouts, chalk, merds, and clay,
Powder of bones, scalings of iron, glass,
And worlds of other strange ingredients,
Would burst a man to name?

SUBTLE: And all these named,
Intending but one thing; which art our writers
Used to obscure their art.

MAMMON: Sir, so I told him—
Because the simple idiot should not learn it,
And make it vulgar.

(*Re-enter* FACE.)

FACE: Here's one from Captain Face, sir, (*to* SURLY)
Desires you meet him in the Temple-church
Some half-hour hence, and upon earnest business.
You'll meet the captain's worship?

SURLY: Sir, I will. (*Exeunt* MAMMON *and* SURLY. *As soon as they have disappeared, a knock is heard outside.*)

SUBTLE: What, more gudgeons! Face, you must go to the door.
Pray God it be my anabaptist; he's to send
A sanctified elder, that shall deal
For Mammon's jack and andirons. Let him in. (*Exit* FACE.)
Now,
In a new tune, new gesture, but old language.—
This fellow is sent from one negotiates with me
About the stone too; for the holy brethren
Of Amsterdam, the exiled saints; that hope
To raise their discipline by it. I must use him
In some strange fashion now, to make him admire me.
(*Enter* ANANIAS.)
Where is my drudge? (*Aloud*)
(*Re-enter* FACE.)

FACE: Sir!

SUBTLE: Take away the recipient,
And rectify your menstrue from the phlegma.
Then pour it on the Sol, in the cucurbite,
And let them macerate together.

FACE: Yes, sir.
And save the ground?

SUBTLE: No: *terra damnata*
Must not have entrance in the work.—Who are you?

ANANIAS: A faithful brother, if it please you.

SUBTLE: What's that?
A Lullianist? A Ripley? Filius artis?
Can you sublime and dulcify? Calcine?
Know you the sapor pontic? Sapor styptic?
And what is homogene, or heterogene?

ANANIAS: I understand no heathen language, truly.

SUBTLE: Heathen! You Knipper-doling! Is Ars sacra,
Or chrysopœia, or spagyrica,
Or the pamphysic, or panarchic knowledge,
A heathen language?

ANANIAS: Heathen Greek, I take it.

SUBTLE: How! Heathen Greek?

ANANIAS: All's heathen but the Hebrew.

SUBTLE: Sirrah my varlet, stand you forth and speak to him,
Like a philosopher: answer, in the language.
Name the vexations, and the martyrizations
Of metals in the work.

FACE: Sir, putrefaction,
Solution, ablution, sublimation,
Cohobation, calcination, ceration, and
Fixation.

SUBTLE: This is heathen Greek to you, now!—
And when comes vivification?

FACE: After mortification.

SUBTLE: What's cohobation?

FACE: 'Tis the pouring on
Your aqua regis, and then drawing him off,
To the trine circle of the seven spheres.

SUBTLE: What's the proper passion of metals?

FACE: Malleation.

SUBTLE: What's your *ultimum supplicium auri?*

FACE: Antimonium.

SUBTLE: This is heathen Greek to you!—And what's your mercury?

FACE: A very fugitive, he will be gone, sir.

SUBTLE: How know you him?

FACE: By his viscosity,
His oleosity, and his suscitability.

SUBTLE: How do you sublime him?

FACE: With the calce of egg-shells,
White marble, talc.

SUBTLE: Your magisterium now,
What's that?

FACE: Shifting, sir, your elements,
Dry into cold, cold into moist, moist into hot,
Hot into dry.

SUBTLE: This is heathen Greek to you still!
Your *lapis philosophicus?*

FACE: 'Tis a stone,
And not a stone; a spirit, a soul, and a body:
Which if you do dissolve, it is dissolved.
If you coagulate, it is coagulated;
If you make it to fly, it flieth.

SUBTLE: Enough. (*Exit* FACE.)
This is heathen Greek to you! What are you, sir?

ANANIAS: Please you, a servant of the exiled brethren,
That deal with widows' and with orphans' goods,
And make a just account unto the saints:
A deacon.

SUBTLE: O, you are sent from Master Wholsome,
Your teacher?

ANANIAS: From Tribulation Wholsome,
Our very zealous pastor.
SUBTLE: Good! Have you brought money
To buy more coals?
ANANIAS: No, surely.
SUBTLE: No! How so?
ANANIAS: The brethren bid me say unto you, sir,
Surely they will not venture any more
Till they may see projection.
SUBTLE: How!
ANANIAS: You have had,
For the instruments, as bricks, and lome, and glasses,
Already thirty pound; and for materials,
They say, some ninety more: and they have heard since,
That one, at Heidelberg, made it of an egg,
And a small paper of pin-dust.
SUBTLE: What's your name?
ANANIAS: My name is Ananias.
SUBTLE: Out, the varlet
That cozened the apostles! Hence, away!
Flee, mischief! Had your holy consistory
No name to send me of another sound,
Than wicked Ananias? Send your elders
Hither, to make atonement for you, quickly,
And give me satisfaction; or out goes
The fire; and down the alembecs, and the furnace,
Piger Henricus, or what not. Thou wretch!
Both sericon and bufo shall be lost,
Tell them. All hope of rooting out the bishops,
Or the anti-Christian hierarchy shall perish,
If they stay threescore minutes: the aqueity,
Terreity, and sulfureity
Shall run together again and all be annulled,
Thou wicked Ananias! (*Exit* ANANIAS *in a panic of fear.*)
This will fetch 'em,
And make them haste toward their gulling more.
A man must deal like a rough nurse, and fright
Those that are forward, to an appetite.
(*C-U-R-T-A-I-N*)

Act II

TIME: *The present. A modern laboratory: as the curtain rises* DEAN *and* YUMM *are busy making adjustments on a very complicated apparatus*

synthesized from radio tubes, Geissler bulbs, or any other available equipment which looks sufficiently impressive. Several noise-making devices should be included.)

DEAN: A trifle less resistance in that field coil;
Now raise your voltage—Steady! There! 'Tis finished:
My dream of nine long years is realized;
You see before you, boy, a *working* model
Of my improved Magnetic Atom-crusher.
(*Gloats over apparatus, rubbing his hands; continues to make small adjustments as he talks*):
Now dawns a brand-new era in our Science.
How many centuries have patient chemists,
Seeking the Stone of the Philosophers,
The Elixir of ancient alchemists,
Worked down from aggregate to particle,
From compound down to simple element,
From molecule to atom—there to stick!
The wealth of energy within the atom
Lay tightly locked: no man could find the key.
But *now*, thanks to the radio's advances,
We force our way into the nuclei,
And shovel out the quanta like so much sawdust.
What is that phrase one hears so often nowadays?
Ah, yes! I have it! "Calorific Canine!"

YUMM: I think you must mean "Hot dog!" Don't you, Doctor?
(DEAN *has picked up a letter from the table and is reading it. He answers absently*):

DEAN: Eh? Oh, by all means! (*Reads*) "Therefore, if convenient,
Will call upon you Friday.....Yours, F. Oyle."

YUMM: The millionaire promoter, Fewes L. Oyle!
He must have heard some rumors of your work,
And comes to ask you for a demonstration.
What was it you said? "Incandescent Airedale!"

DEAN: (*With growing excitement, making small adjustments to machine*)
A demonstration? He shall have it, boy!
A demonstration such as Dr. Langmuir*
Nor any of his gifted fellow-workers
Has ever dreamed of!

YUMM: (*Aside*) Well, I should hope not,
Unless he had a nightmare!

DEAN: Mind you, Yumm,

* Insert name of local celebrity if desired.

This Oyle is but a layman; we must make
Our demonstration and our explanations
So elementary, so absurdly simple,
That ev'n his untrained mind can grasp the process,
And realize its vast potentialities.

YUMM: This Oyle, I take it, then, is rather crude?

DEAN: Crude, possibly, but smooth—

YUMM: And not too thick, eh?
(*Knock is heard*)

DEAN: This must be he—go, Yumm, and show him in!
Oh, if my efforts only could persuade him
To lend financial aid to my research,
In ten more years I could rewrite our Science!
(*Enter* OYLE *and* MRS. OYLE, *in very impressive style*)

OYLE: Well, well! So this is where you hang out, eh, Perfesser?
My name is Oyle. I guess you've heard of me.
(*Indicates* MRS. OYLE) Like you t' meet my wife.

DEAN: Charmed, I am sure. (*Bows deeply*)
And this is my assistant, Mr. Yumm.
(OYLE *spies apparatus and approaches it with interest*)

OYLE: Say, that's a pretty Ritzy radio outfit!
I've got a twelve-tube set myself—cost plenty,
But brings 'em all in, clear to Honolulu.

YUMM: What about static? Do you get that often?

OYLE: No, *never!* (*Emphatically*)

MRS. OYLE: But he could, though, if he tried!

DEAN: Perhaps your error is a natural one, Sir:
This apparatus that you see before you
Will open up undreamed-of fields of power,
And make us masters of the universe!
It taps the sub-atomic energy,
As I shall demonstrate—but first, a word
Of explanation: (*Slowly and impressively*)
What we call the laws
Of force are not mechanic-arithmetical,
But logarithmic-geometrical. I aim
To postulate the relative categories
Of small and large—

OYLE: Say! Just a minute! Son (*to* YUMM),
Would you mind telling what that means in English?

YUMM: Why, he's explaining how this device functions.
You see (*explaining apparatus*), this temperatometer extends
From half the height of nothing down to zero,

And where the contravaxant meets the spantom—

MRS. OYLE: Professor! What's the name of that thing there?
Wouldn't it make a *darling* ash-receiver?

DEAN: I fear we waste time. Come, the demonstration!
This core of magnet-iron is rich in carbon;
When I reverse the current through my field coil,
The atoms of the iron are thrown first one way
And then the other. Hear them shifting over!
(*Manipulates keys: succession of crashes, etc.*)
If I reverse the current very swiftly
The atoms of iron are tossed in wild confusion.
(*Manipulates keys—automobile Klaxon blares;* OYLE *and* MRS. OYLE *jump and get behind their chairs*)
The atoms of *carbon*, caught in this mad vortex,
Are crushed into their separate electrons,
Giving out vast quantities of energy.
(*Manipulates keys—Geissler bulb phenomena and succession of explosions*)

MRS. OYLE: That sounded like Chicago coming in!
How *interesting*, Professor!

OYLE: (*Reseats himself*) But what's it good for?

DEAN: I've just been trying to explain, Sir,
In this device I have a source of power
So vast, so readily available,
'Twill revolutionize our industries,
Abolish war, and change all civilization. (*Hesitates*)
All that we need is—er—financial aid
To subsidize our research. Half the cost
Of your imported car would guarantee
The expenses of this whole investigation. (*Hesitates*)
You follow me, I trust?

OYLE: (*Grunts*) Humph! Follow you?
I'm seven blocks ahead of you, Perfesser!
You want me to put up the cash for this.
(*Takes out cigar, bites off end, and fumbles for lighter*)
Suppose I did—what is there in it for me?
You aim to make big money with your process?

DEAN: Why, no! My pay will be the satisfaction
Of having made a lasting contribution
To knowledge, and the progress of the race.

OYLE: That don't buy any Rolls-Royce limousines!
(*Lighting cigar and replacing lighter in pocket*)
If that's all you can offer for the money,

Why, count me out, Perfesser! I'm not interested.

DEAN: Not interested? Then why visit me at all?

OYLE: Oh, yes! Why, here's the way it is, Perfesser:
(*Leans forward, lowering voice to confidential tone*)
I've got a chance to get a barrel of "hootch;"
The fellow says it's real old pre-war stuff—

MRS. OYLE: He means each drink is followed by a fight!

OYLE: I'd like to have you analyze this stuff (*Pulls out flask*)
And see how it tests up.....That's what I came for.

DEAN: Is that all? (*Sinks back against table dejectedly*)

MRS. OYLE: (*Brightly*) No; I have a problem too:
I'd like to ask, Professor, if you know
Of any chemical that I could use
To take off cigarette stains from the fingers?
(DEAN *rolls up his eyes in despair*)

YUMM: (*Spitefully*) Try concentrated H_2SO_4!

MRS. OYLE: Oh, will that do it? Thank you very much! (*Makes note*)

OYLE: (*Rising*) Well, how about it? Want the job, Perfesser?
(DEAN, *head bowed on his hand, shakes head and waves him away*)
No? Well, I'm sorry to have troubled you.
(*Replaces flask and crosses stage; turns at door*)
It's funny how you chemists waste your time
On truck like *that* (*points*) when you might make good money
By tackling something *useful*. Well, Good-night!
(*Exeunt* MR. *and* MRS. OYLE)

DEAN AND YUMM: (*in unison*) GOOD-NIGHT!
(DEAN *sinks into chair and buries face in hands, while* YUMM *looks toward exit with fists clenched as CURTAIN falls.*)

Study Preservation of Lemon Juice. Lemon juice is such an important source of vitamin C that many efforts have been made to find conditions under which it can be stored without losing its anti-scorbutic power. John Williams and J. W. Corran, working at the Carrow Works in Norwich, England, have found that vitamin C in lemon juice is particularly unstable in the presence of preservatives. Potassium metabisulfite, which is the best preservative for lemon juice against fermentation, was found to have a definitely destructive action on vitamin C. The same was true of other preservatives such as sodium benzoate, formic acid, and oil of cloves. The best way of storing lemon juice without destroying the vitamin was to adjust the acidity with hydrochloric acid to a certain definite point. When this was done, the anti-scorbutic action of the lemon juice was preserved even after keeping at ordinary temperatures for fourteen months.—*Science Service*

THE PROBLEM OF THE ONE-YEAR COURSE IN CHEMISTRY FOR THE GENERAL STUDENT

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For the general student the standard introductory college course in chemistry is too technical while the "pandemic" course is too superficial and informational. Modern physics has supplied an entirely new understanding of matter by way of electronics, radiation, X-rays and radioactivity. Using this approach instead of the classical proof that matter "acts as if" it were composed of atoms, the concepts of atoms and atomic structure can be used as the basis for the periodic system, valence, and chemical reactions. Such a course involves much more physics than the standard course and requires good lecture experiments but not individual laboratory work. To meet the just requirements for a "cultural" course it must emphasize the research point of view throughout and exemplify the scientific method.

. . . . . .

"Education is what is left when all that was learned has been forgotten." This very liberal concept of a liberal education lies at the bottom of the ever-growing protest against the courses in chemistry as now offered for students who are not specializing in the subject. There is substantial agreement among the critics. Administrators, teachers, students, alumni, and public men deplore the lack of any tangible benefits to the vast majority of students who take a year of chemistry, or a year of any other science for that matter. The essential argument is that professional training and education are two different things.

The best statement of the situation was made by President Nicholas Murray Butler (*1*). It is worth quoting at length:

> The domain of science itself has expanded by leaps and bounds. New knowledge of the most amazing and unsuspected kind has constantly been revealed by eager investigators. The steadily improving microscope and newly discovered instruments and methods of precision and measurement gave man a grasp of the infinitely small which no imagination could have forecast a few years earlier. Applications of scientific knowledge to practical life and to industry are multiplied manyfold, and the daily life of millions of human beings is revolutionized and made vastly more comfortable, more safe, and more healthy in consequence.
>
> The essential fact in all scientific study is the use and the comprehension of the scientific method. Nothing is to be taken for granted and no test, whether quantitative or qualitative, is to be overlooked. Every conclusion as it is reached is held subject to the results of verification, modification, or overthrow by later inquiry or by the discovery of new methods and processes of research.
>
> One would suppose that after a half century of this experience and this discipline the popular mind would bear some traces of the influence of scientific method, and that it would be guided by that method, at least in part, in reaching results and in formulating policies in social and political life. If there be any evidence of such an effect, it is certainly not easy to find. Passion, prejudice, partisanship, unreason still sway men, whether as individuals or in the mass, precisely as if scientific method had never been heard of. How is it possible that with all the enormous advances of science and with all

its literally stupendous achievements it has produced such negligible results on the mass temperament and the mass mind? This is a question which may well give us pause, for something must be lacking if intelligent men and women, long brought into contact with scientific method and scientific processes, pay no attention whatever to these, and show no effect of their influence, when making their private or public judgments.

One begins to suspect that the teachers of science themselves may have failed in making effective their science and their scientific method in this sphere of their larger usefulness. There can be no question that the decline in interest and authority of the ancient classics as educational instruments was hastened by, and indeed was in no small part due to, the manner and method of teaching those subjects that became substantially universal some sixty years ago. Minute matters of grammatical, linguistic, and archaeological importance were dwelt upon and magnified to the exclusion of the larger and broader interpretation of the meaning of the life, the thought, and the civilization of the ancient Greeks and Romans. Emphasis was increasingly laid upon the training of accurate and meticulous classical scholars, which was all well enough in its way, but which was something quite different from using the ancient classics as effective and stimulating educational instruments for the great mass of men. It is a sorry, but safe, reflection that had the classics been properly taught and presented in school and in college they would not now be in their parlous situation. Can it be possible that something of the same sort is about to happen in the case of the natural and experimental sciences? If these subjects are to be presented only for the purpose of training specialists, and if the methods to be followed are those that, while appropriate for investigation, have no relation whatever to interpretation, then it may well be that in another generation general interest in the natural and experimental sciences and general knowledge of their meaning and significance will have greatly declined. If these disintegrating forces are at work, then it is quite useless to cite present statistics as to the extent and popularity of science teaching and science study as evidence that existing conditions will continue indefinitely.

If one desires to be a physicist, a chemist, or a biologist, and is ready and willing to devote his time and his energy to that end, then the methods now in vogue in the colleges and universities are excellent. If, however, one wishes to know what physics, chemistry, and biology are about, how they came into existence, what has been their history, who have contributed in most important fashion to their advance, how they are related to each other and to other branches of knowledge, and what is the significance of their present conclusions and applications, then he will find it very difficult indeed to get guidance or help from any teacher of physics, of chemistry, or of biology. In fact, many of these teachers do not possess this sort of knowledge. This was not always the case. Faraday could interpret as well as investigate and stimulate investigation; Helmholtz and DuBois Reymond were past masters of the art of scientific exposition and interpretation; so were Huxley and Tyndall and Kelvin. Why must the science teachers of today turn their backs upon the example and the achievements of these great masters, and neglect the opportunity which is daily offered to make science and scientific method a real and commanding factor in the life of tens of thousands of human beings by explaining to them what science is all about? The making of a few score of admirable specialists, the training of a few hundred research students and the annual production of a small army of youth with narrow, if minute, information useful in some particular vocation, is a sorry substitute for reaching the great mass of the population with the influence and the ideals of scientific inquiry and scientific method.

Nothing can so quickly or so surely kill any subject of instruction and deprive it of its influence as an educational instrument as uninspiring teaching or the stubborn insistence upon false methods. Surely, the example of the ancient classics ought to

suffice. They were killed largely by those who taught them. Men of light and leading are everywhere trying to resurrect the classics from their academic grave and to re-establish them where they belong as a chief foundation of all liberal education. It would be poor business indeed if, while the ancient classics are being resurrected, the natural and experimental sciences should be led by their teachers into the valley of the shadow of academic death.

Following this broad indictment we have had numerous expressions from chemists and educators testifying to the futility of our professional courses for the non-professional student. It has been shown (*2*) that ten per cent or less of the students who take the first-year course in chemistry follow it with any other work in the subject. Tests on ten thousand students have shown (*3*) that the information imparted to the students in our present courses is largely forgotten. "There is no escape from the conclusion that specific information about the subject matter is rapidly forgotten. The absence of functional value of the subject matter is established by the fact that it is forgotten." The blame is attributed to the intense specialization of professional faculties (*4*), to the misconception that the logical and detailed development of a subject develops a discipline, a mental faculty which is independent of the functional value of the subject (*5*), to the modeling of even high-school chemistry on the advanced professional courses (*6*), and to the ignoring of the wider social point of view (*7*). There is general agreement that significance is lost when the technic of the subject is stressed, including under that term all the meticulous details of professional training such as the classical or historical development, the systematic cataloging of facts and properties, the writing of equations, the development of laboratory skill, and, in short, all those parts of the course which are essential to professional training.

The net result of such courses and their tragic cost to the nation was exemplified in an address given by a political leader, then senator from the State of New York, at a banquet of the chemical engineering industry held in connection with the National Exposition of Chemical Industries a few years ago. The distinguished senator opened his address by claiming kinship with the chemists. He too had had a course in chemistry. Yes, well he knew that water is H_2O and, more than that, alcohol is C_2H_5OH! But beyond that he admitted that the course in his case had not "taken."

"Pandemic" Chemistry

These criticisms have been so frequently and so ably expressed that there is now general agreement that something ought to be done. The question is, "What?" Here various ideas are just being formulated. Bancroft (*8*) startled the chemical world by announcing "pandemic chemistry" as a new concept, conceived according to the definition of the term as "pertaining to all the people." Chemistry as such deserves the adjective

but the course outlined does not, since the common meaning of the word is "everywhere epidemic." In spite of the demand for revision, the incidence of such a course can only be called sporadic.

The intention was put in the following words:

> What we need as a cultural course in chemistry is a course which will cover all the ground given in the universities without going into too much detail. This means a series of popular lectures covering the whole field of chemistry as well as it can be done in the time. . .It will not teach the student any chemistry to speak of. It will teach him about chemistry and it will give him an interest in chemistry which will stay with him throughout life.

Bancroft's challenge has called forth many interesting responses. The Chicago Association of Chemistry Teachers, functioning through the Chicago Section of the American Chemical Society (*9*), had presented the following objectives, referring primarily to high-school courses, even prior to the birth of pandemic chemistry:

> 1. To bring about as soon as possible the pupil's appreciation of training in scientific method and chemical knowledge. 2. To teach pupils the understanding and use of the scientific methods in solving problems. 3. The correlation of facts to build a unit of knowledge (a principle or law). 4. Application of principles and laws to new situations in the solving of daily problems. 5. Coöperation in community groups to promote human welfare. 6. Development of moral law and a religious attitude in daily life.

Bawden (*10*) announced as his objectives:

> 1. Chemistry must be presented from the viewpoint of service. Robinson says an appreciation course should "be so ordered and presented in school and college as to produce permanent effects and attitudes of mind appropriate to our time and its perplexities." 2. Emphasis on the applications of chemistry. 3. The scientific method must be emphasized. 4. A broad unified view of chemistry must be presented. 5. A proper balance of theory and application is essential to an appreciation of chemistry.

Sampey (*11*) has perhaps gone farthest in the development of such a course. He agrees with the stated objectives and lists his own purposes as:

> 1. To give the student a keener appreciation of the creative age in which he lives, which centers around the problem of how chemistry has re-created our civilization.
> 2. To teach the scientific attitude of mind.
> 3. To promote the cause of chemistry by enlisting the interest of the public in its problems.

However much sympathy these various proposals have aroused they have failed to satisfy the professors of chemistry. The most common objection is that such a course is necessarily superficial. The major difficulty is that we cannot teach the applications of chemistry to industry and life before the student has a foundation of facts and theory. The result is a fear that such a course will lack solidity, will be entertaining and interesting but, being purely informational, will be forgotten as

swiftly as are the technical details of the classical course and will leave only a vague impression that chemists are somehow responsible for our present world, without even that residue of mental discipline and the memory of hard work which the present course does supply. When books like "Creative Chemistry" (*12*), "Chemistry in Industry" (*13*), and the recent "Stuff" (*14*) are used as texts, the thorough chemist may be forgiven for questioning the permanent value of the instruction. Such courses are undoubtedly pleasant and probably interesting. They need not be "snap courses" but they somehow offend our professional sense that a college course, if it is to have educational value, must give understanding and insight into the how and why and cannot be content with mere description. As John Langdon-Davies (*15*) has said:

> The facts of science should never be treated as *wonders* to be greeted with little shrieks of surprise in drawing-rooms after dinner, or to be used as *fillers* at the bottom of a column devoted to the latest murder in the daily tabloid journal. . .Yet how often is this the only attitude to be found in popular scientific writing. . .The fact (that the young of certain insects devour the living meat of paralyzed caterpillars) does stimulate the imagination merely as a peculiarly horrible fact: the young lady in the deck-chair crossing the Atlantic shudders and exclaims "ugh! the brutes"; the convinced rationalist mutters "and then people believe in a benevolent creator"; the old colonel exclaims "worse than Bolshevist," and all three go on to read that an express train going at sixty miles an hour would take years and years to get to the sun, or Jupiter, or the nebula in Andromeda, as the case may be. It is significant that the daily paper supplied on Atlantic liners for the delight of men and women recovering from seasickness is full of such paragraphs as these.

Technicalities or Superficialities

Stafford (*16*) expresses a startling pessimism based on a third of a century of teaching. He doubts the educational value of the standard course and agrees with Whitehead (*17*) that "the most useless bore upon God's earth is the merely well-informed man," and "the acquisition of inert ideas is the most serious obstacle to be encountered in the educational processes." On the other hand, he states that orientation courses "are doomed to failure for the simple reason that in them also altogether too much is attempted for the time that is available. To obtain the values aspired to is the task of four years or six years rather than of one." He accordingly recommends the scrapping of the first-year chemistry course and substituting for it and others a unified, coherent, progressive program of orientation starting in the grade school.

In the present stage of the discussion we face a choice between too many technicalities in the standard course and worthless superficiality in the proposed remedies. There are, however, several proposals aimed at a middle course. Timm (*18*) considers that the need of a course for the non-specialist student is established and that the presentation of the

properties of one element after another and the drill in equation-writing have no place in such a course. On the other hand, he expresses the conviction of many chemistry teachers in stating that a chemistry course devoid of theory and full of applications is unfortunate and should be reversed. He speaks for a course in the philosophy of chemistry which would have as its objectives:

1. To develop the appreciation of scientific procedure as it has been applied in the derivation and testing of the fundamental theories of the physical sciences.

2. To teach how the results of research are published, abstracted, tabulated and brought together in monographs and textbooks, and how to use this literature.

3. To give a knowledge of the application of these theories to the development of natural resources, to the problems of industry and to those of the daily life of the individual.

4. To treat the development of theory from an historical point of view in so far as is consistent with a presentation of the subject matter which is pedagogically sound.

Brinkley (*19*), surveying the same field that has been covered thus far in the present paper, also takes an intermediate position, stating that a course can be developed which is neither classical nor pandemic "but far more valuable than the mere preparation for qualitative analysis or the gaining of a smattering of either industrial applications or theoretical considerations." He is convinced that the majority of teachers will agree that the chief objectives which we are striving to attain are as follows:

1. Chemistry is an experimental science owing great value in one's cultural education to the insight which it affords into a method of thought known as the scientific method. . .By gaining an insight into the chemist's view of matter and its changes the student may broaden his intellectual horizon by a new point of view in the study of facts and methods which are peculiar to chemistry.

2. A true understanding and appreciation of the significance of chemistry under conditions of modern civilization should be developed as fully as the time devoted to the course permits. . .The economic applications of some of the more important substances should be an integral part of the course. . . One intelligently visualizes the economic importance of substances only when one understands the properties and reactions which give them their importance.

3. The correlation of the facts, laws, and theories of chemistry with other sciences and with our ordinary habits of thought. . . The placing of chemistry in its proper relation (to other sciences and professions) affords a true estimate of its great importance.

4. We should inspire our students with a sense of confidence not only in the scientist and his work but also in themselves. . . It is of fundamental importance. . . to make progress very slowly and to deal with simple scientific concepts, starting whenever possible with familiar facts and working out from these to broader and more complete knowledge. . . It is relatively unimportant whether we complete some particular syllabus or not, if. . . we can give our students the consciousness of their own mastery of that portion of the subject which we do cover. . . I advocate cutting ruthlessly the amount of both descriptive and theoretical material (selecting) those topics which are essential to the attempt to attain the objectives of the course.

These objectives are broad and wise. Professor Brinkley is right in assuming that most chemistry teachers will support them. They would

seem easy to attain. As he says, it is neither important nor desirable that the actual content of the courses which are best suited to accomplish these results should be worked out in exactness of minute detail, because each teacher should choose the material best suited to his individuality and methods.

The Value of Laboratory Work

There are, however, two questions of content which deserve attention from those who are planning courses on this basis. One concerns the value of laboratory instruction, and the other the increased effectiveness of such a course through the introduction of modern physics.

There is no doubt that experience in the laboratory is invaluable, if not indispensable, to the student who is to specialize in chemistry. It provides the essential training in laboratory manipulation and manual skill; it gives the feel of reality and of personal conviction; it emphasizes the universal appeal to the facts. In the course of four years it produces the habit of mind that a scientist must have.

In theory these same points are true for the general student also. It is nevertheless the conviction of a large proportion of teachers that for such students laboratory work is futile. The results are by no means commensurate with the enormous investment in laboratories, equipment, and instruction. The students are not ignorant of the laboratory; nearly all have had some sort of laboratory experience in the secondary school; and they have chosen to specialize in subjects other than science partly because physical experimentation does not appeal to them. The result is that they enter the laboratory courses with aversion or hostility. This is not directed at the concrete thinking demanded but at the requirement of manual dexterity. They almost always enjoy watching the experiments and discussing them but are helpless in actual execution.

It cannot be contended that the drill in physical skill is of any value to such students. Under our modern process of education they have been exposed to that sort of thing almost since infancy and their aversion to it is a sound psychological reaction based on at least ten years of experience. It cannot be changed by two or three hours a week for one more year when they have reached the age of seventeen. Nor is dexterity by any means necessary to them in later life. A journalist, lawyer, or teacher of languages gets along quite well without it and, in any case, cannot acquire it so late in life.

A better argument for laboratory instruction is that it exemplifies the scientific method and forms the basis of the reasoning process. This is a point of prime importance and is certainly true of experimentation as such. It has yet to be proved, however, that this purpose is better accomplished through the simple experiments performed by the student

himself than through competent and thorough lecture experiments conducted by the instructor.

Such a student has a wrong attitude of mind for receiving this benefit from laboratory work. It remains a puzzle to him and his attention is wholly occupied with the mysteries of apparatus and manipulation. The logic of the experiment is missed. He learns in the classroom, from the textbook, or from other students. The experiments assigned to the class are such as can be easily done by large numbers of untrained students. They are simplifications which all too easily degenerate into illustrations. They are routine and set in nature. They cannot be varied even if the student should develop an investigative turn of mind. In contrast to this the lecture experiment can always assume the aspect of research. Any point in the argument may be tested as the class brings up a question. No equipment can be so complicated or expensive as to exclude adequate experimental proof. Finally, these points which are irrelevant to the student, namely, the details of design and manipulation, need not come to his attention. For these reasons I am convinced that the general student learns much more from competent lecture experiments conducted by a skilled instructor than he does from the simple routine and illustrative experiments performed by himself. The two or three hours a week devoted to laboratory instruction can be much more profitably employed in classroom discussion.

If to these considerations is added the unquestionable fact that in a large number of colleges and normal schools the majority of students receive no instruction in chemistry whatever because of the impossibility of providing laboratory space and equipment for the thousands of general students, then the conviction of the chemistry professor that his subject cannot be taught without student laboratory work becomes a very grave obstacle to the proper place of chemistry in general education.

Furthermore, recent research in education has provided an impressive amount of material indicating that the lecture experiment method of instruction yields better results than the laboratory method. Bawden (*10*) has made a thorough study of the published work on this point and quotes letters from many prominent educators to the same effect. Among those who take this position are: Powers (*20*), Anibal (*21*), Carpenter (*22*), Pugh (*23*), Lucasse (*24*), Knox (*25*), and Downing (*26*). Horton (*27*) has made a very complete experimental study of this point in the teaching of high-school chemistry and finds very little difference in the results of the two methods when tested by the ordinary written examination, although students who had done the laboratory experiments themselves showed more success in all non-written tests than those who had merely witnessed demonstrations, *i. e.*, they were better able to manipulate apparatus and to conduct experiments and solve projects in laboratory situations. Yet

the abilities developed in the laboratory are not transferable as an ability to solve problems in other fields. He gives preference to individual laboratory work without directions, *i. e.*, the problem method in which the student plans his own experiments. But he recommends discontinuance of the individual laboratory work and the substitution of demonstrations, after a preliminary period of laboratory training.

The evidence presented by these authors is impressive that individual laboratory work does little more than develop laboratory skill and that the acquisition of knowledge and the understanding of the subject result almost, if not quite, as well from lecture demonstrations. If this is true in high-school teaching, there are additional factors in college work which throw the balance in favor of lecture experiments, namely: 1. The development of laboratory skill as such for the general student is not a justifiable use of precious college time. 2. All the work reported compares identical experiments done by the instructor and by the student; but the great value of the lecture experiment is that important, comprehensive, critical, and investigative experiments may be conducted by the instructor while the student experiments must by their nature be simple and routine. 3. In many colleges the large mass of general students must forego any work in chemistry if laboratory work is essential to it, for it is not financially possible to provide laboratory space and equipment for such large numbers; on the other hand, a course with lecture experiments is easily provided and opens opportunity for the course in chemistry to all students. On this basis my own experience leads emphatically to the conclusion that for this type of student a course based on lecture experiments is decidedly preferable to one requiring student laboratory work.

It should be pointed out, however, that such lecture experiments in the absence of student laboratory work deserve very careful study. In two respects the lecture experiments as often conducted are inadequate. In the first place, the apparatus used is left over from a previous age when classes were small. For large classes everything must be designed and constructed on an exaggerated scale; special devices must be used to make the experiments effective and especially to make the measurements visible to the entire class. An experiment which is not visible to each student had better be omitted. This will require the development of large-size apparatus and instruments and the special attention to lecture-table apparatus on the part of the equipment dealers. In the second place, the lecture experiments lose most of their effectiveness if they are "lecture demonstrations." Any demonstration is inherently an offense against the scientific method. If, in addition, it is invisible, we are teaching chemistry based on the authority of the professor. No matter how much we rail against the medieval worship of authority and exalt the scientific method, we defeat our ends if the student is convinced merely because the

professor says so. If we have been accused of this, we have taken comfort in the thought that the student's own laboratory work supplied the defect. In so far as his experiments are illustrative this is not the case. Lecture experiments should be investigative, should furnish definite and convincing facts for the mind of the student, and should be variable to meet the need of the argument and the inevitable questions from the intelligent students. So conducted they do accord with the scientific method and constitute the most valuable portion of a course in chemistry.

The Problem of Selection

The second major point concerning an adequate course for the student who is not specializing in chemistry is a question of content. Obviously, it cannot be a course in chemistry. It must constantly be borne in mind that not one of the students will ever be a chemist, nor even an engineer or a physician. The students are interested in understanding the civilization about them and the scientific factors of daily life but they are not interested in chemistry for its own sake nor is it the intention of the course to proselyte them.

On the other hand, the purpose of the course should be much more serious than merely to "popularize" chemistry. A number of recent books, in an effort to be pandemic, have gravely underestimated the intelligence, the serious purpose, and the real desire for understanding that characterizes the college or normal-school freshman. They have been written to amuse, to interest by the methods of the Sunday comic section and to charm the student into an appreciation of chemistry by a recital of its marvels. Such books serve a purpose with the casual reader whose mental diet is journalistic. They might even be suitable for sophomores. But the severest indictment of American college education is the tragic deterioration and disillusionment of the student on his road to the sophomoric state. Freshmen arrive unspoiled, full of ideals, earnest in their desire to understand. Under our mass enrolment their average intelligence is not high but their desire to learn is real. No course that they take is better fitted to feed their eagerness and to give them a wise outlook on life than a course which examines modern civilization from the scientific point of view. To underestimate both their intelligence and their thirst for knowledge by reciting an interminable list of superficialities, proving over and over again that chemistry is the root of all good, is a travesty on education and a grave offense to young minds that are eager to grow.

A satisfactory course must therefore exemplify the scientific method of thought and the scientific attitude of mind. It must include the common experiences of daily life, the important technical developments that have made our civilization what it is, and the outstanding factors of the social environment which are apparently political or economic but are predestined

by science. It must succeed, in President Butler's words, in making science and the scientific method effective in this sphere of their larger usefulness. It must therefore combine the essential viewpoint of such books as Slosson's "Creative Chemistry" with the sound and convincing development of scientific concepts as they are found in the standard texts, but to do so it must omit from these latter everything that can be called "chemistry for chemistry's sake."

This, it seems to me, is best done by starting with a kettle of fish. Bancroft (*8*) recounts the story of Agassiz who, on being asked by a student beginning his course whether he would start with a general classification, replied: "No, we shall begin with a bushel of clams." In other words, the subject of discussion should be not the Principle of Archimedes but the problems offered by the Zeppelin, not the Law of Definite Proportions but the tremendous industrial problem of corrosion, not the Bohr theory of the atom but the fascinating puzzle of the nature of reality. It should anticipate that the student will remember nothing except the method of attack on such problems and the fundamental concepts which result from their analysis together with the ability to apply these methods and concepts to the host of unknown phenomena that he will meet in later life.

The responsibility of the professor, therefore, is to choose for discussion such phenomena as are important and as will reveal the most significant fundamental concepts. Others must be omitted if only for lack of time. This requires a perspective which is regrettably lacking both in those who are deep in their researches and in those who have for many years taught prospective specialists. By and large, a philosopher or an active literary critic could perhaps make a more competent choice than those who are closer to the subject. Yet any competent chemist at the end of a month's vacation could jot down a list of basic concepts which cannot be omitted in any such course.

This is not written argumentatively. Indeed, I presume that there will be general agreement up to this point. The differences appear when we get down to brass tacks. My own conviction is that the entire problem revolves about the presentation of the atomic theory. We may ignore all books and methods which simply state, *ex cathedra*, that atoms are and act thus and so. For the rest, the classical method is designed to prove that matter *acts as if* it were composed of atoms. To do so requires a long train of reasoning including simple chemical reactions, presented before they can be understood, the fact and implication of molecules, analysis and the calculation of chemical composition, the laws of definite and of multiple proportions, the gas laws, volume relations in gaseous reactions, combining weights, equivalent weights, formula weights, molecular weights, and, finally, atomic weights. Before the evidence is all in, a mass of technical chemistry must be covered. There has until re-

cently been no other method of establishing the atom. This, it appears to me, is the primary reason why our courses in chemistry have been too technical for the general student, and our courses about chemistry have been too superficial to be effective.

The Atom by Way of Modern Physics

But the fact is that an entirely new route to the same end is now open. Physics of today has proved that matter is composed of atoms. We can hardly even speak of an atomic theory. By numerous methods atoms are manipulated one by one. By means of alpha ray tracks they can even be made individually visible. Physics has rendered our classical approach to the atom completely obsolete. The evidence is simple and the argument is direct. It is time to incorporate the new point of view in the introductory course.

This is the more to be desired because the steps in the argument include only realities that should be mastered and understood for their own sake and omit all purely technical and fictitious concepts. On the way to the atom it is necessary to build up convictions as to the significance of mass, inertia, time and space, density, cohesion, temperature and heat, energy, the three states of matter, dispersion, molecules, radiation, electrons, X-rays, positive rays, and radioactivity. Each of these is real. Each involves concepts which are indispensable to an understanding of the universe. There is hardly one that is not being discussed today at intellectual dinner tables. Presented progressively, they form a solid basis for the understanding of the atom, of atomic structure, of valence and the periodic system and, therefore, of chemical reactions. Students introduced to chemistry by this route are not lost in a jungle of technicalities; chemical reactions appear simple and even the writing of equations involves no difficulty. Once this point has been attained these basic concepts and others which are dependent on them can easily be developed by analyzing any of the outstanding phenomena of the age, such as the automobile, aviation, the steel industry, nutrition, or photography. By restricting the list of concepts to those which are vital in this sense a course can be constructed which is at every moment significant to the non-chemist and yet always retains the chemical attitude, method, and conceptions, and thus accomplishes every objective that can be desired.

There are at least three objections to such a course. The first is that many classical subjects in the chemical vocabulary must either be omitted or much reduced in emphasis. The theory of ionization is an example. Here each teacher will have to make his own choice, but it is worth pointing out that many of the subjects which are stressed among chemists provoke among outsiders, and especially among students, a puzzled "Well, what about it?" In the modern world of the quantum theory and relativity,

chemists are still lecturing as if Arrhenius needed defending. With the electron established, his theory is simple and almost obvious. It can be inserted where and when it is needed but it is by no means of such major importance to the non-chemist as to justify the time that is ordinarily given to it. The same is true of other favorite chapters in our chemical texts.

A second objection is that such a course is to a large extent one in physics rather than in chemistry. This, however, is a necessary consequence of the nature of the phenomena and is no new thing in chemical history. The same was said of the use of the gas laws in establishing atomic weights, of the application of spectroscopy in analysis, of the introduction of electrochemistry, etc. The fact is that by drawing on physics chemistry has repeatedly simplified its own concepts as well as its methods, for the simple reason that physics is of a piece with chemistry and fundamental to it. The organization of our universities into departments is not based on any model in nature. She presents us with molecules in motion; neither is comprehensible without the other. If for specialist purposes it becomes necessary to set one man to studying the molecule and another the motion, it is absurd for each of them to address the passer-by as if the other did not exist and to expect him to obtain an intelligent picture from these separate and possibly contradictory points of view. For the general student such artificial lines must be eliminated. Indeed, this is imperative because in very few colleges does the general student receive a course in each subject, and a single course combining the essentials of both can give a precious insight into the physical world without becoming in any sense merely an "orientation course."

Finally, there is the practical objection that these new developments in physics are not adaptable to student laboratory work. He can hardly construct and operate an X-ray spectrograph, not to speak of observing and measuring the deflections of alpha rays. But we have already discussed the insidious futility of individual laboratory experiments. The conviction expressed earlier in this article becomes more impressive when thorough and illuminating experiments in such subjects, competently conducted on the lecture table, are compared with the trivial experiments that are the usual lot of the chemistry student. It is true, however, that an effective course of this kind requires the investment in considerable lecture equipment of a type which is neither familiar to chemistry faculties nor commonly supplied by the apparatus dealers. The investment, however, is markedly less than that required for an expensive laboratory which is used but a few hours a week. Much of the equipment is available from scattered sources and this is being added to steadily. For that which is lacking an excellent substitute can be provided in the form of lantern slides and such outstanding motion-picture films as "Beyond the Micro-

scope," produced by the General Electric Company. Certainly it will be but a short time until this physical obstacle to such a course is removed. The committee on Visual Aids in Chemical Education of the Division of Chemical Education of the American Chemical Society has already published excellent lists of such slides and films (*28*).

The Research Point of View

I cannot omit one further observation that has no logical place in this discussion but which is essential to the purpose to be accomplished. It appears to me evident that the answer to the question as to why fifty years of science teaching has not established the scientific method in popular thought is that the non-specialist student never gets the feel of it. In the first place, his laboratory work is illustrative rather than investigative. In the second place, the instruction in all sciences, and especially in chemistry, is authoritative and depends largely on drilling. In sum, the attitude of the student is receptive (if it is not hostile), while the professor is a teacher, an instructor, a drill-master. All too often the purpose is to build up a body of knowledge; rarely is the course designed to stimulate real thinking. We try to illustrate the scientific method by the historical account of the great discoveries. It fails of its purpose because the student is exterior to the illustration. A description of a scientific argument remains a description. The scientific method can become part of the student's innate equipment only if he himself has the research attitude of mind toward the subjects presented to him. If the course is to develop a sound, scientific method of thought, it must be addressed to the inquiring mind and not to the memorizing mind. Each subject must be introduced as a problem and must be solved by and with the students by the methods of experiment and logic. Both students and professor must constantly be asking questions. The technic of questioning, of investigating, is the scientific method.

Such a course as outlined above is peculiarly susceptible to this method of study. It is as effective for those who have had chemistry in secondary school as for those who have not. It avoids that repetition which is perhaps the most serious objection to our present courses. The work of the secondary school is necessarily too elementary to include more than a few of these concepts and then only in a superficial manner. Secondary school science can perhaps be taught; college science should intrinsically constitute a series of research problems.

The development of such a course will be a matter of time and chemists will never be unanimous as to its precise content. There will probably be more variation in the future than in the past because more and more the task will be a matter of selection. There is no hope of including everything, and research developments will probably come faster than new

textbooks can be written. Yet the objective is clear and the methods are at hand. We can at least expect agreement that recent research in physics has changed the landscape and that it has provided the chemist with an enormous simplification of his outlook. The public is fully aware of it. Books on the atom, the electron, and relativity have reached the ranks of best sellers. It is hardly conceivable that the student in the liberal arts, or in education, should go through college without understanding the physical universe. He will have much to live through, for at the present pace our idea of the universe will be revised in every decade. The least that we can do for him is to give him the best picture that is available today together with sufficient understanding of the methods of inquiry to enable him to keep up with what will undoubtedly for the next generation be the outstanding feature of our civilization, namely the advance of research in the physical sciences.

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THE FRESHMAN COURSE IN CHEMISTRY FOR STUDENTS WHO HAVE HAD SECONDARY-SCHOOL CHEMISTRY*

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In order to obtain the most satisfactory results, students who have had secondary-school preparation in chemistry should, in college, be instructed in courses in which the presentation of the subject is entirely different from the elementary course, not only in point of view but also in the order of the presentation of the subject. Only a small per cent of these students have a sufficient knowledge of the subject to justify the omission of further work in general chemistry. A course has been in use for a number of years, designed to cover the subject in a series of major topics in each of which the student is encouraged to go as far as his ability and interests permit by the use of several different texts, books of reference, and journal articles. The course is sufficiently flexible to permit its modification to the needs of the students, whose preparation in a number of different schools varies greatly.

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Formerly the most general practice was to include in one course all students entering a first college course in chemistry, whether they had previously taken a preparatory school course in the subject or not. Exceptions to this procedure were introduced by organizing a small division of the best students as a sort of "honors division" and giving them a different treatment, such as a course in qualitative analysis. The majority of the students who had previously studied chemistry in the schools were, however, for many years required to take the same elementary course in college that included beginners also. Indeed, this is still the practice in many of our smaller colleges.

This treatment of necessity fails to yield the best results for either group, those who have had school preparation in chemistry and those who have not. The students already somewhat familiar with the subject are bored by the elementary nature of the work, feel that they know all about it already, and do little preparation for the daily assignments. By the time topics which really are new to them are introduced, they have gotten into a mental state toward the subject which prevents mastery of these; and an unnecessarily large number of them fail, even in the elementary course. The beginners in a mixed course of this type feel that they are under a handicap in that they are in classroom competition with students who already know something about the subject and can show them up in a class discussion dealing with the fundamental concepts encountered in the first part of the course. This treatment seems to the writer to be fair to neither group of students. The students with previous training acquire the habit of trying to loaf through the course; while the beginners have an

* Presented before the Division of Chemical Education at the 80th meeting of the American Chemical Society, Cincinnati, Ohio, Sept. 8–12, 1930.

unnecessary mental hazard in work which they find sufficiently difficult at best.

As the years have passed, the training which students receive in their preparatory and high-school chemistry courses has improved to such an extent that the mixed course has become increasingly unsatisfactory; and it has now become the practice in most of the larger colleges and universities, and in many of the smaller ones, to place these students in separate courses. This seems to be the only logical solution of the problem.

Not only should beginners and those who have had previous courses in chemistry be instructed in separate courses; but these courses should be entirely different in point of view and in the order of presentation of the topics. When the students who have had this previous training are taught in a course which differs from the beginners' college course merely in that they are held to higher standards and a text by a different author is used, little is gained. They still encounter the same topics in much the same order as in their school courses. They still feel that they are on familiar ground and make little effort. They frequently fail to notice that the book they are now studying is much thicker than their high-school text; and that each topic is discussed much more completely. The student of average interest in his academic studies, in a course of this type, rarely pursues a given topic much further than in his previous course. He may read and hear about a few more elements and many more compounds; but usually the point of view is still the same as that from which he had previously been taught. Indeed, with the improvement in the preparatory school courses within the past decade, so much more material is included than formerly was the case that it frequently happens that the student is merely reviewing his school course with only an occasional new fact or idea brought to light. In several of the preparatory school courses with which I am familiar standard college tests are now being used in the chemistry courses. It is little wonder, under these conditions, that the students become bored, fail to acquire the habit of studying thoughtfully, and all too frequently fail to pursue the subject under consideration to a logical end and to acquire the breadth of view and the ability to handle the subject as the college professor expects him to do. This practice has often resulted in the student, who entered college with a year's preparatory school course in chemistry to his credit, actually knowing less about the subject at mid-year than the students who entered with no previous knowledge of chemistry.

This kind of experience has led to the oft-repeated statement that college professors would prefer to have their students come to them unprepared by a previous course in chemistry, as the school courses seemed to do more harm than good. This attitude is manifestly unfair to that great group of teachers in our secondary schools. As a matter of fact, the better the

school course, the less satisfactory will a succeeding college course be, if it is presented from the same point of view and differs from the school course merely in the amount of detailed and specific information, either descriptive or industrial, which the student is expected to commit to memory. It is the writer's contention that the responsibility for the unsatisfactory nature of the work of the students in such courses lies with the college professor rather than with the school teacher whose work he criticizes.

After a number of years' study of this problem and the trial of several different methods of presenting the subject, the writer is of the opinion that the great majority of the students coming from the secondary school courses are not sufficiently grounded in the subject to justify the omission of further work in general chemistry. The scope of the subject is far too great for this reasonably to be expected. The teacher finds so many interesting topics that he wishes to include that he often attempts to teach far too much, being impelled as he is by the urge to acquaint his students with the whole field of chemistry. The result is that the student acquires a knowledge of many of the subjects which is superficial at best. A better foundation for subsequent work in college would be furnished by decreased extent and increased depth, than by the opposite which is the present tendency. However, those students who are sufficiently well grounded in the fundamental facts and principles of general chemistry, possibly ten per cent of those having had the school course, should be given the opportunity to do more advanced work in chemistry. For a number of years it has been our practice to organize a division of approximately twenty-five students whose entrance records are exceptionally good and who desire to get ahead in their work in chemistry. This group is handled as a special course and does the work in qualitative analysis, not, however, in the sophomore course, and in addition is assigned the study of special topics in general chemistry. We consider this procedure to be satisfactory for these especially qualified students, but not satisfactory for the great majority of the entering students who are not so well prepared or who lack the incentive to do the extra work involved.

A special type of course has been developed during the past eight or ten years for the group of students who enter college with the knowledge of chemistry equivalent to that obtained in a good secondary school course. These students are thoroughly familiar with some of the topics, so that it is a waste of time to drill them on these again. They also have a smattering of knowledge about a great many things, not, however, sufficiently thorough to be used without further study. It is our purpose to use this previous training of the student as a foundation upon which to enlarge his knowledge of chemistry. As the preparatory school training becomes better it is possible still further to advance the work in this type of succeeding course. To this end the order of the introduction of the topics is

entirely different from that of the elementary course. The object is not to sugar-coat the pill so as to impose it the more readily upon the unsuspecting student, but to give him a new point of view in the study of the principles of the subject, the development and use of theories, and an understanding of the correlation between the chemical and physical properties of substances and their uses in industry and in everyday life, and a view of the newer developments even though many of these cannot be treated in detail at this stage in the student's work.

The course begins with a consideration of some of the fundamental laws of chemistry and the periodic system. This is followed by a study of atomic structure and these concepts are used throughout the course, in so far as is feasible, in connection with the discussion of valence, oxidation-reduction, and the reactivity of the elementary substances. The study of descriptive facts is arranged under a classification based on the similarity of substances rather than on the elements which they contain. Thus, the acids are studied under one major topic, instead of being treated here and there throughout a number of pages dealing with the non-metals. A large number of substances undergo hydrolysis and certain principles describe this action. The student understands this subject much better when the different types of substances undergoing hydrolysis are studied together to bring out these principles, than when one type is discussed in studying the compounds of a given element while another type is explained weeks or even months later under the discussion of some other element. In each of the descriptive sections, the economic phases of the subject are emphasized in connection with the substances studied to the end that the student may obtain an intelligent idea of the place of chemistry in the modern world. In the discussion of the theoretical topics, the subject is presented so as to show the logic of the theory, its applications, and its limitations.

The treatment throughout the course is based on a series of topics and a certain minimum attainment is required for successful completion of the course. The students are encouraged to go far beyond this minimum by studying a given topic in several texts, reference books, or in journal articles, and by reporting on these topics, either individually to their instructors or, in the case of topics of wide general interest, before the division. This additional work is varied to the interests of the students to cover philosophical phases of the subject, historical aspects, theoretical considerations, or economic applications.

Objection may be raised that this procedure is costly, exacting too much of the instructor's time; and it does encroach heavily upon his time. However, is not the teacher's first duty to look after the intellectual welfare of his students? In the courses in general chemistry there are a larger number of students than in any other course in the department,

often larger than in all of the other courses combined. This group has not in general received the consideration in the provision of teachers to which it is entitled. Provision should be made to furnish a sufficient number of experienced teachers to handle the work for these students in an adequate manner. The inexperienced and part-time teachers frequently have their main interest in graduate work, and cannot be expected to work patiently with a group of freshmen who require a large amount of personal attention. The mass education method of large division lectures as the main method of instruction is not a satisfactory method for elementary students, for one cannot fairly take the attitude that he will present the subject and let the student take it or leave it. This is the most important phase of a student's work in chemistry for his interest in the subject and the success of his later work in it depend in a large measure upon the instructor in the course in general chemistry. This work requires the sympathetic understanding of the teacher who is interested in his students and willing to spend all of the time necessary to lead them on in their work, yet able to detect the imposter and unwilling to be imposed upon by the loafer who is merely seeking a little gratuitous tutoring in his instructor's hobbies.

Experience shows that the students who have had a preparatory-school course in chemistry should, in college, be given an entirely different type of course. Only a small percentage of these students have sufficiently thorough preparation and incentive to qualify them for work more advanced than general chemistry. These may be given a special course in qualitative analysis supplemented by topics in general chemistry and in elementary physical chemistry. A course designed to cover the subject in a series of major topics, presented in a different order and from a different point of view from that of the elementary course, has been in use for a number of years. In each of these topics, the student is encouraged to go as far as his ability and interests permit; and the course is sufficiently flexible to permit its modification to the needs of the students.

Nickel Chrome Alloys. Many alloys of this stainless family have additions of nickel which aid their resistance to oxidation for many purposes, though nickel renders their cutting with tools, *i. e.*, machining, more difficult, and forging is less easy. Some very useful alloys have 15 to 20% chromium with from 1 to 60% nickel. One well-known one is the 80% nickel-20% chrome composition from which the wire of toasters, electric irons, hot-plates, and other household appliances are made. Another is the 8% nickel-18% chrome-74% iron alloy from which sulfur-resistant tubes are made for oil-refining stills, steam boilers and superheaters, paper-mill digesters, and other chemical-resistant apparatus. There are hundreds of other such alloys.

The stainless steels and irons are playing a very important rôle in our life today.—*Science Education*

WHY EVERY COLLEGE HAS A COURSE CALLED CHEMISTRY I

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The syllabus herewith presented is an outline which the author used for a one-hour talk to about 350 freshmen who were registered in an orientation course at The University of New Mexico. A bibliography of interesting, non-technical references is included.

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At The University of New Mexico, following freshman week and continuing for a semester, the freshman class listens to a lecture once each week on the subject of some field of study of fundamental importance to mankind, does supplemental reading, and then takes a quiz.

Men from departments of chemistry in any of our institutions may be called upon at any time for orientation lectures, and the syllabus here printed may be useful to those who have suddenly to perform the service of presenting the field of chemistry to a class of freshmen.

Syllabus

The universal interest of the passing generation in the coming generation.

The desire of older men that younger men shall have the benefit of all human experience previous to the time the latter become adults:

1. The most useful habits
2. The most helpful knowledge
3. The most wholesome attitudes, ideals, and finally
4. Abilities to reflect and reason, that the coming adult may be better able to adapt himself to the ever-changing situations of life.

The older generation (which incidentally generously denies itself many luxuries and often some necessities, that the younger may have a fair, full start in life) entrusts a great part of this passing-on process to experienced specialists: we call them educators.

After years of observation and reflection, these educators realize that, for the good of the coming individual (and society), they must stress these habits, skills, knowledges, ideals, and abilities to reflect toward:

1. Securing better health for the individual and for communities
2. Improving conditions of family life
3. Making it easier for the individual to earn a living, and making economic life of the community better
4. Having a better civic life for the coming generation
5. Securing more recreation for the future and more satisfactory ways of using recreation time
6. Development of ethical character.

The educators, with full consent of those who pay the bills, have placed Chemistry I in the freshman course of nearly every college.

Your speaker's task is to justify this in your eyes. In other words, he must convince you that a knowledge of chemistry is necessary to sanitation and medicine (health), that chemistry has a place in the household (home), that applied chemistry produces wealth (vocation), that social, civic, and governmental adjustments are very much dependent upon what chemists are doing (civic life), that there is considerable correlation between the amount and kind of recreation we have, or may have, and the applica-

tions of chemistry (recreation), and that in some way the work of a chemistry course can help to develop desirable human traits (ethical character).

How has chemistry given us better health?

The importance of health (*1*)
Old conditions of pestilence (*2*)
Superstitions concerning disease (*3*)
Work of the chemist, Pasteur (*4*)
Modern community sanitation (*5*)
Modern synthetic medicines (*6*)
Modern clinics and sanitoria (*7*)

(Chemistry universally a required subject for all health work and for every branch of medicine.)

What has chemistry done for, and to, the home?

The appropriative age of man
The adaptive age of man
The creative age of man

Shelter: Synthetic roofing, artificial lumber, plastics, cements, paints, lacquers, modern alloys (*8*)
Food: Soils, fertilizers, crops, nutriments, vitamins, cold storage, modern labor-saving devices
Clothing: Leather, textiles, dyes

The great disturbance to old-fashioned home life from the factory system.

(Chemistry universally required for all work in home economics, dietetics, nursing, and in every sort of an agricultural course.)

How has chemistry provided vocations (*9*)?

This topic could be the subject of a five-hour course. We must be brief. 17,000 members of the American Chemical Society. Probably 25,000 chemists in the United States.

No industry of any size, today, is without its chemists and its chemical research staff.

(Chemistry universally required for courses in architecture, biology, every branch of engineering, geology, pharmacy, and physics. Most lawyers regret that they have not studied some chemistry.)

Has chemistry improved civic life?

Yes. Land, water, and air transportation and communication (*10*). Thanks to sanitation there are no limits to size of communities.

Yes. (?) The revolution in agriculture, manufacturing, and transportation. "Overproduction," etc.

(Very unfortunately all who direct civic affairs—editors, politicians, statesmen, executives, legislators, and jurists—are *not* required to take a course in chemistry as a part of their college work. They live in a world where everything is affected by some chemical process, yet their judgments, often made in chemical ignorance, affect us all civically.)

Has chemistry given us more or better recreation (*11*)?

Its gift to art and literature
The great time-saving processes
The shortening working period
Things which used to be for the rich and now within easy reach of the poor

Can a study of chemistry develop character?

The spirit of science

The methods of science

"In science the most absolute and unsparing honesty is a prime requisite." E. EMMETT REID (*12*).

The sheer joy of intellectual satisfaction.

The chemistry of the heavenly bodies (*13*)

The chemistry of earth processes (*14*)

The chemistry of ourselves (*15*).

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Millions in Sugar Due to Fertilizer. Five million dollars return from $500,000 investment may be the reward to American sugar planters for taking advantage of scientific methods to increase their sugar-beet crops.

This estimate is made by Dr. Henry G. Knight, chief of the Bureau of Chemistry and Soils, U. S. Department of Agriculture, in his annual report. Although no fertilizer was used on sugar-beets in Colorado, the largest and most profitable sugar-beet territory in the country, when the soil fertility work of the government began in 1922, between 200,000 and 250,000 acres of sugar-beets were fertilized this season, the report stated.

"With an increase of 3 tons to the acre by reason of the fertilizing practice introduced by the department the value of this year's crop would be increased by $5,000,000 less the $500,000 expended for fertilizer," said the official estimate.—*Science Service*

STUDENT GUIDANCE. I. THE SELECTION AND SEQUENCE OF COURSES OUTSIDE THE MAJOR FIELD*

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In recent years much has been written and spoken concerning the training which the college and university should give to the student who expects to enter the field of chemistry. Too little attention, however, has been given to the order of the program. Following the example set by the technical schools, the departments of chemistry in our colleges and graduate schools should give more adequate and detailed guidance to the student in the selection and the sequence of those supporting courses which he should take outside his own major field.

. . . . . .

Within a few days now many of us will be signing or accepting enrolment cards for the various courses in chemistry which we teach. As usual, we shall be on our guard to see that no student enters our class unless he has completed the prerequisites which entitle him to admission. Many of us will also be approving the schedules of our major students. Doubtless, we shall exercise great care to see that each student signs up for the right course in chemistry.

All too often, however, our guidance stops there and the student is left to plan his own four-year program as best he may, in spite of the fact that much has been written and spoken concerning the various fields in which a chemist should be trained.

To be sure, the situation is different in most technical schools, for there the entire course of study leading to a particular degree is published in detail. A student runs little chance of making a mistake in selecting his program for a given semester, for the reason that some one with experience and vision has planned it all out and has prescribed not only the courses which the student is to take in his major field but also those supporting courses which will give him necessary information or desirable training in related fields.

Unfortunately, nothing at all comparable to such detailed programs has yet been worked out and published in many of our liberal arts colleges. Lest I should be misunderstood, let me hasten to state that I am not advocating the abolition of the elective system which exists in most colleges, but I am suggesting that students in liberal arts colleges need more guidance in both the selection of the courses which they are to take and the planning of their future program of study.

If a student is left to select his own program of courses, he is apt to blunder because he lacks experience and perspective. If he drifts into the hands of one of those "campus wise men," who prefer "working a prof" to

* Presented before the Division of Chemical Education at the 80th meeting of the American Chemical Society, Cincinnati, Ohio, Sept. 8–12, 1930.

working a problem, he is apt to hunt for easy courses regardless of how they will fit his present or future needs. If he is advised by some one outside his own major department, he is apt to be advised to get his required courses out of the way at the earliest possible date, leaving his major until later.

This latter advice, although given by mature and sincere advisers, may be almost as bad as for the student to blunder along alone or to hunt for the snap courses, because such advice takes no account of the courses which a student should take in order to support his major or to prepare him for courses which have certain prerequisites which must be met.

Let me illustrate. In many of our liberal arts colleges it is required that a student must complete certain hours in courses distributed among several groups. Suppose that these groups are as follows: (1) English, (2) science or mathematics, (3) history or social science, and (4) foreign language. Suppose further that a freshman, planning to specialize in chemistry but unacquainted in the department, follows the routine of the enrolment and, after such advice as is usually provided, signs up for a course consisting of English, history, Spanish, chemistry, and physical training.

To any one checking the course in the registrar's office it would appear that all was well. The freshman has selected only those courses which will count toward meeting the group requirements. After another year, if he is equally careful in his selection of courses, all the group requirements will have been met, and the student, then a junior, will be in a position to work out his major without the interference of required courses in other fields.

You may not agree with me, but it seems to me that our freshman has made at least two mistakes which were not apparent to persons outside the department of chemistry. First, if he had any idea of becoming a chemist, he should have signed up for mathematics during his freshman year. This would open the road to physics, and pave the way for courses which would enable him to take physical chemistry when the time comes. Second, the Spanish which he elected is not apt to help him much in reading the references to the journal literature which are apt to be assigned in his advanced chemistry.

As a result, difficulties lie ahead which might have been avoided. But, how is a student to know unless such information is brought to his attention either in printed form or as the friendly counsel of a well-informed and interested adviser?

It is possible that the four-year program which you would work out for a chemistry major at your school will differ somewhat from the four-year program which we have outlined for chemistry majors at Ohio Wesleyan. The purpose of the present paper, however, is not to raise questions as

to what courses should be recommended nor to indicate the year in which we believe a certain course should be given, although admittedly these are important problems. What I am trying to suggest is this. Many students encounter schedule difficulties in the later years of their study of chemistry for the simple reason that, somewhere back in the line, they failed to take the right course at the proper time. Indeed, altogether too many students emerge from the college, and even from the graduate school, without properly balanced courses.

It is my contention that most of such difficulties could be avoided if the departments of chemistry should see to it that adequate information and intelligent guidance are available for all who wish to specialize in chemistry. Such a guidance program presupposes that the department of chemistry has studied the problem as it exists in the school concerned, has made contact with and secured the coöperation of the departments which must give the related and supporting courses, has checked the schedule of the college to see that conflicts are avoided, and finally has provided the printed matter, information, and personnel to carry out its program.

A New Container Material. The commercial development of a new process by which asphalted fiber is converted on a standard paper machine directly to a highly waterproof paper board offers many interesting possibilities in the packaging of materials for shipping and distribution. As compared with the conventional type asphalt-saturated papers and boards, the new product is of further economic interest, as it can be made from lower cost raw materials due to the elimination of the rag stock normally required to facilitate asphalt saturation. To permit printing as well as marking, the new board is usually made up with "liners" or facings of kraft paper. The body of this board may be embossed when desired as a further decorative effect.

The new material will maintain adequate strength not only through a wide range of atmospheric conditions from wet refrigeration to a steam-saturated air, but also under the severe test of submergence in water for a twenty-four-hour period.

Fabrication and sealing methods have been developed for the conversion of this board to containers of several types which meet demands previously considered beyond the field of either solid fiber or corrugated stock packaging.

An interesting development is a ventilated container for fruit and produce. If necessary the package may be iced directly without risk of weakening the walls and consequent crushing of the contents. Special types of reinforcing permit the manufacture of this package in rectangular shapes, thus affording maximum economy in space for shipping and storage as well as in icing charges. One element of this reinforcing provides a tray for one layer of fruit at the top of the box, and thus permits uniform display until the contents are completely sold.

Another of these containers meets the exacting specifications for the shipping and handling of dynamite. The folded construction and special sealing where lap joints are necessary makes this container much tighter than any wood construction available at comparable cost.—*Ind. Bull., Arthur D. Little, Inc.*

DEMONSTRATION EXPERIMENTS AND THEIR PLACE IN THE TEACHING OF CHEMISTRY

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The student will learn more chemistry from the individual experiment. The demonstration experiment is a valuable method which may be used to teach facts and principles, and to demonstrate manipulation. For this reason it is a most valuable method for use during the beginning weeks of the introductory course.

Of the three types of demonstrations, teacher, student, and student-teacher, the first is considered in regard to its value to the individual and to the class. Some of the objections raised in regard to the use of demonstration work are discussed. Several points of use in making a demonstration experiment more useful and also some characteristics of a good demonstration are listed.

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When chemistry was first offered as a course in the public schools of this country the experimental work was done by demonstration methods in most cases. There were several reasons for this state of affairs. In the first place there was no ready source of apparatus such as we have at present in our many houses specializing in scientific supplies. Then the apparatus that was available was too expensive for the equipping of a laboratory for each school. And, as our present-day facilities of transportation were lacking, many of the schools were rather isolated from the sources of supplies that did exist. As a result the work that was done in the classes was mostly demonstration work and the simplest apparatus and materials were used.

From this state of affairs we have changed to the opposite and almost every school that has a course in chemistry has a laboratory that is equipped for individual student experimentation, and in many cases all, or most, of the experimental work is individual and there are very few demonstrations. We might say that chemistry has inherited this system of laboratory instruction.

At this point it would perhaps be well to say a word in regard to the place of individual experimentation in elementary chemistry. The psychologists tell us that scientific ability is a complex mixture of native physical characteristics, mental and physical habits and reactions, and emotional attitudes. To acquire a very important part of this group, namely, physical habits and reactions, it is necessary to have a chance to exercise these factors by the use of personal experimentation. If it were not for the skills and habits that are acquired by individual work, we would not have the science of chemistry and the large group of chemists that we have at present. This is just another way of saying that we would not have many of the important processes and products of chemistry which we all enjoy either directly or indirectly and would certainly miss very keenly. After everything is considered the best way to learn to do a thing is to do it, or to apply this to our case the best way to train chemists is to have them

work at chemistry, performing individual experiments. Chemistry certainly is not an "arm-chair" science.

Perhaps the relationship of individual and demonstration experiments may be brought out best by an analogy. We will all admit that it is impossible to teach a person to drive a car by taking him to a busy street corner and having him watch the cars rush past, or even by having him ride with an experienced driver. He must learn to drive by driving. However, it is true that if the student chauffeur knows how to drive a car under ordinary conditions on the open country road he will be able to learn some of the fundamentals of city driving by observing traffic, either from the sidewalk or by riding with an experienced driver. It is just the same with chemistry: the actual driving technic comes from the experiments we do ourselves, and then we are better able to watch another more skilled person perform a demonstration experiment, and we will learn much more from it due to our own slight knowledge of the manipulation required.

It is true that in our schools there are certain students that are more interested in learning *about* chemistry than they are in learning the principles of chemistry. There are enough such students that some of the larger schools have organized classes especially for them. For this type of student the demonstration experiment is more suitable than for those who wish to learn the principles of chemistry. However, even for this type of student it is necessary to teach some of the principles of chemistry, and so since we have both types in any high-school class it is not possible to use one class of experiment exclusively, even if it were desirable. Whether or not transfer of learning is a reality, any student has had a very poor course in a science such as chemistry who finds after he has dropped the science as a formal study that he has nothing that will be of value to him in every-day life.

When we stop to think that chemistry as a modern science has developed in the last one hundred fifty years it is very evident that the subject of chemistry is rapidly increasing in subject matter and in the complexity and number of "every-day" household and industrial applications. As a result it falls to the lot of the teacher to collect and classify material for consideration, rejecting that which cannot be used for one reason or another, in order that the class will be able to cover the maximum of important material in the time available.

While the theory of learning by doing is very important it is impossible to do all of the work that is suggested in the course of a year and so a large amount of it must be omitted, especially if all of the experiments are of the individual type. To help solve this difficulty the demonstration experiment may be used to great advantage by using it as supplementary experimentation. The term supplementary signifies that we would not cut down the number of individual experiments but would increase the

number of demonstrations in the classroom and use them to expand the principles taught by the individual work, or to teach new and more difficult principles. This plan would not only make it possible to cover more ground but it would also make for more thorough treatment of the involved principles, and would give the teacher the best possible chance to correlate theory and data.

There are three types of demonstrations, the teacher demonstration, the student demonstration, and the student-teacher demonstration. In general, the same methods of procedure and the same values may be attached to these three types of experimentation as far as the class as a whole is concerned. However, in the student and the student-teacher demonstrations, the students who take part in the actual work will get much more from the experiment than those who just observe it, and they will usually get more from it than they would if they did the same experiment in the laboratory as individual work, for they feel more responsibility and so will study the experiment more thoroughly. This makes the use of demonstrations very valuable as a means of giving the students who are especially interested in scientific work more difficult problems and at the same time benefiting the entire class. Also the help of students in demonstration work will greatly reduce the time the teacher will have to spend on the demonstration, especially if the student is a good technician and can prepare the apparatus with little or no help. The student help does not relieve the teacher of any responsibility, for, regardless of whether or not he takes an active part in the demonstration, he is, in the end, responsible for seeing that the class understands the principles and facts of the experiment.

In the following discussion the demonstration is considered as a teacher affair. The individual teacher can easily apply the principles set forth to student and student-teacher work.

If the student is to get the greatest amount of benefit from the experiments that are performed as class demonstrations he must be led to think of the principles that are involved, and so it is necessary to use some method of securing this result. Perhaps the best method to use for this purpose is to have the student write up the demonstration experiment as carefully as if it were individual work. Some teachers have a list of mimeographed questions prepared and depend upon them to bring out the main points of the experiment and drive them home. Others depend upon the questions asked in class to bring out the difficulties and main points of the experiment. Whatever method the teacher employs to start the students thinking along the lines of the experiment the best results will be secured only if the student and teacher both ask questions during the time of experimentation. With this plan of procedure the student should develop good reasoning ability, and he will as a rule be interested in the work

since there is a certain fascination in seeing work carried out with actual materials.

The use of the purely spectacular experiment as a demonstration has no place in chemistry classes, for it does not have any point. These experiments may be used for entertainment but not for teaching. The demonstration, to be justified, must have some definite point that will be clearly illustrated. To secure this result there must be some well-defined change that is easily seen from all parts of the room, thus making it easy to follow the course of the reaction and thereby making the experiment more successful as a teaching tool. Many demonstrations fail because the teacher does not see the experiment as it appears to the people in other parts of the room, and so it is pointless as far as the students back of the front row are concerned.

To get the best results it is necessary to use some dramatic principles to secure and hold the interest of the students. It is best, if possible, to have the apparatus set up but not on the lecture table until it is to be used. In this way the experiment is observed while the first interest of the student, which is the strongest interest, is still in operation. Also an interesting piece of apparatus on the lecture table will attract the attention of the students from the discussion of topics related to the demonstration experiment.

During the first part of the year more demonstration work should be used than later in the year. The reason for this is that the student has come into an entirely new situation and as a result he does not have any idea of laboratory technic. If the demonstrations in the classroom show the simple manipulations that the student is first called upon to use in the laboratory the result will be that the student will be able to carry out his experiments with less trouble, and will get more from them than if he were sent into the laboratory and asked to follow printed instructions without any background. At the same time he will be much more apt to form good habits of laboratory technic and will not form so many habits that will have to be reformed. For these reasons it may be justifiable to carry out some parts of the laboratory work for the first day or so in the lecture room as demonstrations, and then have the students repeat them later as individual experiments. But this should not be done after the student has a few basic skills mastered. Throughout the year it is a good idea to demonstrate new and particularly difficult points in technic before the students are required to use them in the laboratory. This may be done by illustrating the difficult point by itself, and does not require the performing of the entire experiment.

The use of too many demonstrations may, from the nature of the typical demonstration experiment, lead the student to think that chemical reactions are always more or less spectacular and very evident in their

changes. Plenty of individual work in the laboratory will guard against this mistaken idea.

There are some objections that are frequently raised when demonstration experiments are suggested to a teacher. Perhaps the first one is that the demonstrations require too much of the teacher's time. It is true that it takes time for the teacher to set up the apparatus and test the experiment before it is used. This objection must be answered by the individual teacher. Perhaps there are students in the class that would be only too glad to help the teacher set up the experiment and test it, and so save much time. The student demonstration is another method of saving the teacher's time.

Another objection is that the demonstration experiment requires expensive apparatus. It is true that some of the experiments do require such apparatus, and those that require very complicated, delicate, or expensive apparatus should be performed as demonstrations. However, surprising results can be obtained by the use of the simple apparatus available to all laboratories. The main requirement in overcoming this objection as to expense is that the teacher exercise a little ingenuity in the use of his apparatus.

Another objection may be that the demonstration teaches the student to watch and not to think. If this is true it is the fault of the teacher, for it is the teacher's task to keep the student thinking and reasoning all of the time a demonstration is going on.

Still another objection is that the demonstration does not teach the student the art of chemistry. This is perfectly true, but the individual experiment will do this and the demonstration is only supplementary.

Also you will hear it stated that too many demonstrations become monotonous. While this is true it is easily remedied. In the first place the demonstrations should be made so interesting that the students will be interested in a large number of them. The demonstration should be used to break the monotony of the lecture period, and should be arranged so that it will show the most possible in the shortest time.

There is no typical demonstration experiment, but there are certain points that must be taken into consideration in planning and performing a demonstration so that the student will get the greatest possible benefit from it. It might be well to list a few of the most important of these points here.

1. The experiment must be as complete and accurate as the time available and the skill of the teacher will permit.

2. The experiment must demonstrate a definite principle or process which is very evident and is not obscured by some minor points that are more noticeable.

3. More than one principle should not be demonstrated by one ex-

periment. If the same experiment is used to demonstrate more than one point is should be performed a different time for each point.

4. The experiment must work quickly and thus avoid the loss of valuable class time.

5. The apparatus must be as simple as possible so that it will be easy to follow the process, and so the apparatus will not attract the attention of the student from the process demonstrated.

6. The action to be studied must be clearly visible from all parts of the room. If the students on the back row cannot see what is taking place they will get very little benefit from the demonstration, and will often distract the attention of those who could observe the reaction and so spoil the experiment for them.

7. Test the experiment just before the demonstration to be sure that the desired result will be obtained. It is poor teaching, and very embarrassing, to explain why an experiment is a failure.

8. Permit the students to examine the apparatus and samples of the materials and products after the class period.

The success of the demonstration depends upon the teacher. There are no definite rules that may be laid down and the results guaranteed if the teacher follows them. One teacher may have fine results and another fail utterly with the same demonstration when using the same apparatus and the same general plan of procedure. Therefore the extent to which demonstrations are used and the details of procedure in the experiments depend upon the individual teacher, and he must work out his own policy.

In conclusion, remember that the demonstration is a method of teaching and so the student should be held responsible for the principles shown and for the facts. The demonstration teaches principles and facts while the individual experiment adds technic to the list. The demonstration is a means to an end and not an end in itself.

Humble Water Plant Makes Much Limestone. Limestone, or what will eventually be limestone, is manufactured in thousand-ton lots in shallow lakes in the Middle West. So much is indicated by researches conducted by Prof. H. A. Schuette and Hugo Alder of the University of Wisconsin and the Wisconsin Geological and Natural History Survey.

The two chemists analyzed quantities of Chara, a water-weed that grows freely in the ponds and lakes of limestone regions. Its stems and leaves are harsh and rough to the touch, indicating the presence of considerable quantities of mineral. The analyses showed the sand-free, air-dry plants to contain over 41 per cent of ash, of which much the larger proportion was calcium carbonate, captured out of solution in the lake water.

In the lake where the analyzed samples were collected, about half the mass of the yearly crop of aquatic plants is accounted for by Chara. With this as a basis, Prof. Schuette and Mr. Alder calculated that this one plant yearly returns to the bottom of this lake something like a thousand tons of calcium carbonate.—*Science Service*

LECTURE DEMONSTRATIONS IN GENERAL CHEMISTRY*

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In lecture experiments the course of a given chemical reaction is often followed by observing the rate at which a gaseous product is evolved. This can be done by attaching a rubber balloon to the container in which such a reaction is taking place and noting the rate at which the balloon is inflated. Several experiments of this type are described. Directions for the preparation of pyrophoric lead and iron and the formation of silver and lead trees are also given. Demonstrations of the absorption of certain gases and the use of glass wool in lecture experiments are also described.

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In connection with demonstrations in general chemistry the author has noted the desirability of showing the audience in a semi-quantitative way the rate at which gases were being evolved from various chemical reactions. In certain cases it was found that the demonstration could be very satisfactorily made by slipping the neck of an ordinary ten-cent balloon over the neck of the flask containing the reactants and following the evolution of the gas by watching the rate of inflation of the balloon. This simple bit of technic can be applied to a number of types of reactions, three of which will be described.

The Preparation of Hydrogen

To show the influence of metallic copper on the reaction,

$$Zn + H_2SO_4 = ZnSO_4 + H_2,$$

place 150 cc. of 2 *N* H_2SO_4 in each of two 500-cc. flasks. To one flask add a few crystals (0.2 g.) of $CuSO_4 \cdot 5H_2O$ and allow them to dissolve. Obtain two ordinary rubber balloons, place in each ten pieces of zinc (C.P.) rod $^1/_4''$ diam. by $^1/_2''$ in length, then stretch the neck of each balloon over the neck of a flask, making sure that the zinc stays in the balloon. Lift the balloons so that the zinc will fall down into each flask. In a short time hydrogen will begin to be evolved and the balloons will inflate. In the flask to which the copper was added the balloon will inflate much more rapidly.

Promoter Action in the Decomposition of Hydrogen Peroxide (*1*)

In general promoter action refers to reactions in which a mixture of two substances acting as catalysts produces a greater catalytic effect than can be accounted for on the assumption that each substance in the mixture acts independently.

* The author wishes to acknowledge the assistance of MR. DAVID FOLTS, DR. DONALD GRAHAM, and MR. HOMER KLINE in connection with the development of certain of these demonstrations.

Materials: 300 cc. H_2O_2 solution made by diluting Merck's 30% solution with three volumes of water.

$CuCl_2$ solution (35 g. $CuCl_2 \cdot 2H_2O$ liter).

$FeCl_3$ solution (250 g. $FeCl_3 \cdot 6H_2O$ per liter).

3 rubber balloons.

Three 500-cc. flasks.

Procedure: Place 100 cc. of the H_2O_2 in each of the three flasks.

To flasks 1 and 2 add 5 cc. of water.

As quickly as possible add:

5 cc. of $FeCl_3$ to No. 1,

5 cc. of $CuCl_2$ to No. 2,

5 cc. of $FeCl_3$ + 5 cc. of $CuCl_2$ to No. 3,

and slip the balloons over the necks of the flasks. The flask No. 3 will show a much more rapid evolution of gas than No. 2. The catalytic action of the $CuCl_2$ alone is very mild.

Note.—Working at the University of Wisconsin, Dr. V. L. Bohnson has shown that for Cu^{++} and Fe^{+++} used together, the velocity of decomposition of H_2O_2 was 467. The value calculated from the velocity constants obtained when the two salts were used separately in the same concentrations was 174, the promoter effect being almost 300%.

Relative Strengths of Acids

The materials needed are: $^1/_4''$ magnesium rod cut into pieces $^1/_2''$ long; 2 *N* HCl; 2 *N* H_2SO_4; 2 *N* $HC_2H_3O_2$; three 500-cc. flasks and three large balloons.

Procedure.—Put fifteen pieces of the magnesium in each balloon and the three acids in the three flasks, 200 cc. in each flask. Attach the balloons to the flasks and raise them when it is desired to drop the metals into acids. Using balloons of five liters capacity, at the end of one minute the HCl, H_2SO_4, and $HC_2H_3O_2$ were expanded to diameters of about 5″, 4″, and 1″, respectively.

This experiment may be carried on in connection with the classical experiment (*2*) devised by Whitney, in which the relative electrical conductivities of the three acids are shown, thus correlating chemical activity with electric conductivity of the acid.

Modifications of Some Well-Known Experiments

The following experiments will be recognized as standard. Certain details of technic have been worked out in this laboratory by which these experiments have been improved, hence their inclusion in this paper.

Lead Tree.—From a sheet of zinc cut strips about $^1/_8''$ by 6″. Procure a piece of wooden rod $^3/_8''$ in diameter and 6″ in length and drill $^1/_8''$

holes through it every half-inch of its length. Stick the strips of zinc through the holes, bend and trim them to the proper lengths to simulate a tree. To support the tree, stick it in the hole in the base of a Bunsen burner that has been removed from the tube. Place the tree in a large beaker and fill the beaker with 5% lead acetate solution.

Silver Tree.—Use stout copper wire for the branches of the tree, with a 2% silver nitrate solution.

Pyrophoric Lead.—Place lead tartrate in a 6″ soft-glass test tube to about one-third of its volume, heat the test tube about an inch from the end, and draw it out so that the opening just permits the passage of a $^1/_4$″ glass tube. Clamp the test tube in a horizontal position and by means of a glass tube conduct a stream of illuminating gas into the test tube so that the gas passes over the tartrate. Light the gas at the mouth of the tube. A tiny flame ($^1/_2$ inch) indicates sufficient gas. Heat the lead tartrate with a burner and keep the temperature low by moving the flame as soon as a sodium flame appears. When no more fumes are evolved, remove the burner and the illuminating gas tube, and immediately seal off the end of the tube. To ignite, break the end of the tube with pliers and allow the loose powder to drop through the air. For pyrophoric iron proceed as above using ferrous oxalate.

Note: If the tartrate is heated too much the lead will not ignite when thrown into the air. This is also true of the ferrous oxalate and iron.

Common Ion Effect.—This experiment shows in a striking way how the presence of an excess of acetate ions reduces the activity of acetic acid solution.

Procedure: Place a layer of precipitated $CaCO_3$ about $^1/_4$″ thick in each of two glass cylinders about 4″ × 15″. About 40 g. of $CaCO_3$ is enough for each cylinder. Prepare two 200-cc. portions of 2 *N* acetic acid solution, and saturate one portion with sodium acetate crystals. As nearly simultaneously as possible pour each portion on one sample of $CaCO_3$. In the case of the pure acetic acid the carbon dioxide foam will rise much more rapidly than with the other acid, indicating its greater activity.

The Adsorption of Gases.—A classical experiment to show the solubility of NH_3 in water consists in collecting a tube of NH_3 over mercury and slipping a fragment of ice inside the tube. The ice melts at once and the NH_3 is dissolved. The experiment may be used to show the combination of NH_3 to form $CuSO_4 \cdot 4NH_3$ and similar compounds. The anhydrous $CuSO_4$ is pressed into the form of a pellet and slipped into the tube of NH_3 in place of the ice.

The adsorption of NH_3 by charcoal may be shown by using recently heated coconut charcoal in place of the ice.

If sufficient mercury is not available the ammonia may be collected over carbon tetrachloride and the ice experiment carried out as before.

The adsorption of ammonia in charcoal can also be carried out in this way, but because of the appreciable solubility of the gas in CCl_4 the experiments are not as satisfactory as with mercury.

The Use of Glass Wool in Certain Experiments

To show the action of chlorine gas on turpentine dip a few grams of glass wool in *warm* turpentine, squeeze out the excess of liquid, and drop the wool into a jar of chlorine. The reaction is more certain and more striking than the usual method of carrying out this experiment by moistening filter paper with turpentine.

The action of nitric acid on turpentine is readily shown as follows: in a glass cylinder about two inches in diameter, place enough glass wool to make a plug 2–3 inches deep. Pour about 5 cc. of warm turpentine on the wool then drop 2 cc. of yellow fuming nitric acid on it by means of a glass tube. After a few seconds the turpentine will burst into flame.

To demonstrate the oxidation of hydrogen sulfide by nitric acid place a piece of glass wool about the size of an egg in a shallow dish, pour 3–5 cc. of the fuming nitric acid on it and bring hydrogen sulfide gas in contact with the acid by placing the tip of the delivery tube under the piece of wool. The oxidation is so vigorous that the gas takes fire.

The Density of Ammonia

The large rubber balloons (15–20 liters) when filled from an ammonia tank will rise at once when released. After a few minutes the ammonia will diffuse through the rubber and the balloon will begin to sink.

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By-Products of Wood Pulp Studied by Swedish Chemists. Swedish chemists are at present engaged in research for the recovery of by-products from the manufacture of wood pulp.

According to a recent announcement, two Swedish chemists attached to the Swedish College of Pharmacology have obtained a patent on a method for the extraction of phytosterin from sulfate soap (pine oil). It is claimed that this substance will prove a substitute for lanoline and rape oil as the base of salves and marine oil.

It is further stated that at least 18,000 tons of pine oil can now be recovered from the manufacture of sulfate pulp in Sweden, whereas the actual production is only about 5000 tons. If sulfate soap corresponding to a quantity of 18,000 tons of pine oil is treated for production of phytosterin it would yield about 450 tons of this product, which, if used for marine oil, would yield no less than 90,000 tons of oil. Although the practical utility of the method has not yet been tested on a large scale the inventors think that it will prove a valuable means to reduce the cost of the pulp making and thus make the operations far more profitable.—*Science Service*

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THE QUANTITATIVE TREND IN GENERAL CHEMISTRY LABORATORY COURSES*

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Numerous typical general chemistry laboratory texts published during the last forty years have been examined and studied as to the proportion of the quantitative experiments found in them. An examination of the results shows that there has been very little agreement in the proportion of quantitative experiments which were included in freshman work, and that this proportion does not vary in any simple way with the date of publication of the laboratory manual.

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A recent discussion among teachers of inorganic chemistry courses prompted the query: To what extent should quantitative experiments be employed in first-year laboratory work? In an attempt to determine how far various schools go in this direction the author undertook a review of a number of laboratory manuals. It is hoped that the results of this research might be useful to others in planning freshmen laboratory outlines.

The number of books examined included twenty-seven laboratory manuals covering the period of the last forty years. The institutions at which these texts were written are among the most representative schools in the United States, but no attempt was made to make the list all inclusive. No doubt many important texts were overlooked, but at some future time a more exhaustive study will be attempted. In the examination of a text, experiments were deemed quantitative when in the usual sense of the term they employed quantitative or physical measurements.

The following list of findings is self-explanatory:

Percentage of Quantitative Experiments in First-Year Laboratory Texts

Year of Publication	*Author*	*Institution*	*Percentage of Quantitative Experiments*
1891	SMITH and KELLER	U. of Penna.	8
1891	COOKE	Harvard	34
1895	BARTLETT	Dartmouth	25
1899	HILLYER	Wisconsin	6
1901	CONGDON	Drexel	6
1902	DENNIS and CLARKE	Cornell	5
1907	KAHLENBURG	Wisconsin	10
1911	RANSOM	Purdue	20
1913	NORTH	Rutgers	4
1914	NEWELL	Boston Univ.	10
1917	BYERS	Washington Univ.	11
1921	MCPHERSON and HENDERSON	Ohio State Univ.	12
1923	BRAY and LATIMER	U. of California	30
1924	KENDALL	Columbia	8

* Presented before the Division of Chemical Education at the 80th meeting of the American Chemical Society, Cincinnati, Ohio, Sept. 8–12, 1930.

Year of Publication	*Author*	*Institution*	*Percentage of Quantitative Experiments*
1926	DEMING and ARENSON	Nebraska	30
1926	HOLMES	Oberlin	7
1926	HEATH and BEISLER	Florida	13
1926	SCHLESINGER and LINK	Chicago	12
1927	LONG, CHAMBERLIN, and ANDERSON	Lehigh	20
1927	SNEED and KIRK	Minnesota	9
1927	BRINKLEY and KELSEY	Yale	9
1928	BLANCHARD	De Pauw	8
1928	BELCHER and COLBERT	Oklahoma	27
1929	RICHARDSON and SCARLETT	Dartmouth	12
1929	EVANS and DAY	Ohio	10

An examination of these results shows that there has been very little agreement in the proportion of quantitative experiments included in freshmen work. Before starting this investigation we felt that there would be a general upward trend in the amount of quantitative work done in freshmen courses. However, a chronological plot of these results would show as bad a set of peaks and depressions as any stock market report.

The general average of the proportion of quantitative experiments is fifteen per cent. This figure may be used as an approximate guide, although excellent recent texts have been written with the number of quantitative experiments varying from ten to thirty per cent of the work.

It is difficult to adequately explain differences, but some opinions may be hazarded. In the first place the writer of a text is, by his own training and research background, often influenced in his selection of experiments. To be sure he should not let this dominate his teaching methods, but it will unconsciously exert an influence. The whole spirit of certain institutions is more largely physical and quantitative than that of other colleges. A second reason for the variation is due to the differences in previous training of the students. To students who have had a good course of elementary chemistry before entering college, a more advanced course of quantitative experiments is usually given. Beginning students must first be introduced to the subject before they can handle advanced experiments. Most laboratory texts are written to satisfy both classes of students and the usual procedure is merely to omit or include certain experiments according to the qualifications of the class. Hence it is almost impossible in examining a text which has, say, twenty per cent of its contents covering quantitative experiments to say that the freshmen course at that institution has that same proportion of quantitative work. One section of the class may be doing fifty per cent quantitative work, while another section would probably do only five per cent.

The stress placed on quantitative work may also be determined to some extent by the subsequent courses to be taken by a student. There

is a trend in several institutions to offer a course in pandemic chemistry to students who do not expect to major in chemistry. It is too early to properly evaluate the results of such courses. However, it is the opinion of some of our older and more experienced teachers, that if you lead a student through a course in beginning chemistry without showing him the exactness of the science, you have done both student and science an irreparable injury. On the other hand, it is wise to offer a note of caution on the attempt to overdo quantitative work. If a student has not acquired sufficient skill to enter the quantitative stage of chemistry you may handicap him seriously by giving him erroneous ideas which will affect his later studies in analytical and physical chemistry.

Some instructors take the extreme attitude that all first-year work should follow the historical order which the science developed of first qualitative and then quantitative study. The answer to this argument is best given by Smith and Hall (*1*):

> The history of modern chemistry begins with Priestley, Lavoisier, and Cavendish, but it was the quantitative part of their work which alone really deserved the designation fundamental. It is difficult to see why a pupil should be dragged through a fog-bank of alchemy and empiricism simply because the rest of the world lost its way and wandered in such a fog for hundreds of years.

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Crystal Changes Show How Rocks Develop. A broken bit of rock stuck under a microscope can tell the inquiring scientist how hot the earth's crust was when it formed. At the recent annual exhibit of the Carnegie Institution of Washington the new methods of crystal study developed at the Institution's geophysical laboratory were demonstrated.

Any substance that occurs in crystalline form will present a whole series of different appearances, according to the temperature conditions prevailing when the crystals are building themselves up. Common silica, best known in the form of white sand, assumes at least seven different forms between ordinary temperatures and white heat. Other rock materials are as versatile, and by looking at the types of crystal present in them it is possible to read much of their history.

Another exhibit that is attracting much attention is one of a peculiar one-celled marine plant, valonia, whose cells are so big they can be handled like eggs, and will survive surgical operations. Some of these cells have had tubes set into their walls, have healed up around the foreign body, and conduct their normal lives regardless of the intrusion. This enables experiments to be performed showing the cell's capacity as a conductor of electricity across its protoplasmic layer.

How living cells march, then rest, then march again is shown in a series of motion pictures of the migration of white tissue cells. These pseudo-independent units in our bodies migrate more or less as they please. The film shows that they travel in a rhythmic cycle, moving along energetically for a time, then rolling themselves up into little balls, then unrolling to resume their travels again.—*Science Service*

THE STUDY OF ISOMERISM IN COURSES IN GENERAL CHEMISTRY

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The study of isomerism receives much attention in courses in organic chemistry, but almost none in general chemistry courses. This is unfortunate, for inorganic chemistry offers many interesting and instructive examples of isomerism. The isomerism of the different forms of mercuric sulfide and of mercuric iodide is most evident in physical properties; that of iron disulfide is shown in chemical properties also. Isomerism is beautifully illustrated by such cases as that of hydroxylamine nitrite and ammonium nitrate and that of the two forms of phosphorous acid, which show a keto-enol tautomerism. Many examples of optical isomerism are known among inorganic substances; some of these owe their activity to the structure of the crystal, some to the presence of an asymmetric atom.

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The opening chapters of nearly every textbook of organic chemistry include a discussion of the differences between organic and inorganic chemistries. The fact that the former contains innumerable examples of isomerism, while the latter does not, is often mentioned (*1*). The attitude that isomerism is a part of organic chemistry is widespread, and courses in general chemistry seldom mention the topic. There is little basis for this attitude, for inorganic chemistry offers many examples of isomerism that can easily be introduced, even into a beginning course. These are both interesting and instructive, and will certainly stimulate any student's imagination. It is true that we do not understand the cause of the isomerism in some of these cases, but this does not detract greatly from their value, for most students are attracted more by the unsolved mysteries of chemistry than by the things which have been well established and are completely explained. The purpose of this paper is to point out a few of the many cases of isomerism which may be used in a course in general chemistry.

Many simple inorganic substances exist in two or more forms which differ in color, specific gravity, crystalline form, and other physical properties. Mercuric sulfide furnishes a good example of this sort of isomerism. The naturally occurring cinnabar is red and has a specific gravity of 8.17; the sulfide obtained by reaction of mercuric salts with hydrogen sulfide is black, and has a specific gravity of 7.60. The black form is changed into the red upon sublimation, or upon standing in contact with an alkaline solution (*2*). This reaction is exothermic. Still a third form of mercuric sulfide may be prepared by the reaction of sodium mercuric chloride with sodium thiosulfate. Like cinnabar, it is red; its density, however, is only 7.2. Manganous sulfide also exists in isomeric forms; the usual flesh-colored one, and an olive-green one. The two forms of

antimony sulfide are not isomeric; the orange precipitate obtained in the laboratory differs from the black mineral stibnite only in particle size. It changes slowly into stibnite on standing in contact with hydrochloric acid.

The red, monoclinic mercuric iodide changes to a yellow, tetragonal form when it is heated above 128°C. On cooling, this reverts to the red form. Some of the double iodides of mercury show similar changes at fairly definite temperatures (*3*). Thus both cuprous mercuric iodide and silver mercuric iodide change from a light red to a deep brown between 70 and 80°C. but revert to the light color on cooling. All of these changes may easily be demonstrated by warming the materials; the mercuric iodide must be heated over a flame, but the double iodides may simply be placed in a test tube which is immersed in a beaker of boiling water. The cuprous mercuric iodide is made by grinding cuprous iodide with twice its weight of mercuric iodide; the double silver salt in the same way from silver iodide with one-fifth its weight of mercuric iodide. By mixing these substances with oil, heat-sensitive paints are prepared. Such paints are used in the approximate measurement of temperature; to guard against overheating of the bearing boxes of machinery, for example (*3*).

Every one who has prepared oxygen by heating mercuric oxide has noticed the gradual darkening in color as the temperature is raised. This, unlike the color change in mercuric iodide which we have just discussed, is not accompanied by a change in other physical properties, such as crystalline form. According to Capstick (*4*) the molecules in the solid vibrate about certain mean positions. As the temperature is raised, the amplitude of vibration increases, and so the longer wave-lengths of light are reflected. Ackroyd (*5*) has advanced a similar explanation. Many substances show color changes of this sort—mercuric oxide, zinc oxide, lead oxide, lead chromate, copper borate, and others. Conversely, many compounds lose their color on cooling to very low temperatures; among these are chromic chloride, chromic alum, phosphorus pentabromide, and manganese iodide. The changes in all of these cases are gradual and seem to be limited entirely to variation in color, so it is a matter of opinion whether or not they should be considered as isomeric changes.

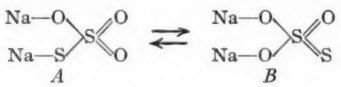
The isomerism of iron disulfide is a striking case. This substance occurs in nature as the minerals pyrite and marcasite, which differ in crystalline form, color, density, hardness, and other physical properties, as well as in chemical properties. On standing in the air, marcasite readily oxidizes to ferrous sulfate, while pyrite is but little changed. Concentrated nitric acid dissolves pyrite completely, but it leaves a copious deposit of sulfur when it reacts with marcasite. Of the two, marcasite is the more unstable, for it is converted into pyrite upon heating (*6*). The structures of these two forms of iron disulfide have not been established; both of them seem to contain only divalent iron (*7*), though even that is uncertain.

Several cases of structural isomerism, in which the structures are better understood, may be cited. Paal (*8*) has prepared hydroxylamine nitrite, $NH_2OH \cdot HNO_2$, which is isomeric with ammonium nitrate, $NH_3 \cdot HNO_3$. Sabanejeff (*9*) has prepared a whole series of compounds of the same sort, for example, $NH_2OH \cdot H_3PO_2$ and $NH_3 \cdot H_3PO_3$; $N_2H_4 \cdot (H_3PO_3)_2$ and $(NH_3)_2 \cdot H_4P_2O_6$. Uranyl sulfite, UO_2SO_3, which Kohlschütter (*10*) has prepared, and uranous oxy-sulfate, $UOSO_4$, reported by Giolitti and Bucci (*11*), furnish another example of true structural isomerism. Aside from these, very few isomeric pairs have been synthesized, although many should be capable of existence—for example, sodium seleno-sulfate,

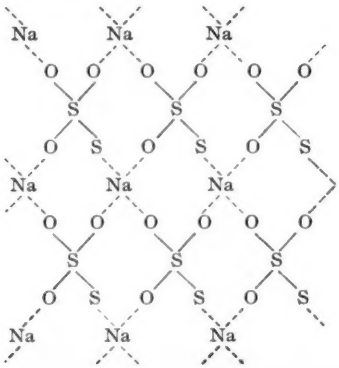
and sodium thioselenate, , ammonium metaphosphate, NH_4PO_3, and phosphonium nitrate, PH_4NO_3; thallic orthophosphate, $TlPO_4$, and basic thallic metaphosphate, $TlOPO_3$. (In each of these cases the first compound mentioned is known, the second is unknown.)

The isomerism of ammonium cyanate and urea has attracted much attention ever since Wöhler's classic experiment in 1828. This pair of isomers is noteworthy in that one of the substances is organic, the other inorganic. Similarly, ammonium thiocyanate, which we use so often in testing for iron, is isomeric with thiourea.

The structure of sodium thiosulfate has received a great deal of attention, and it has been suggested that this compound should exist in two isomeric forms:



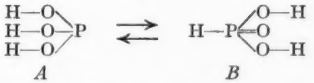
This, however, does not seem probable in view of the fact that crystalline substances are ionized, even in the solid state. Thus, in a crystal, there is some such arrangement as below.



It can be seen from this that it is quite immaterial whether we depict a single molecule by formula *A* or formula *B*.

W. A. Noyes (*12*) has suggested that nitrogen trichloride might exist in two forms; ammono-nitrogen chloride, $\overset{---}{N}\overset{+++}{Cl_3}$, and nitro-nitrogen chloride, $\overset{+++}{N}\overset{---}{Cl_3}$. Though he has been unable to isolate the second of these two compounds, he has obtained some evidence for its existence. He designates isomers of this type as "electromers."

Phosphorous acid offers an excellent example of structural isomerism of the keto-enol type:



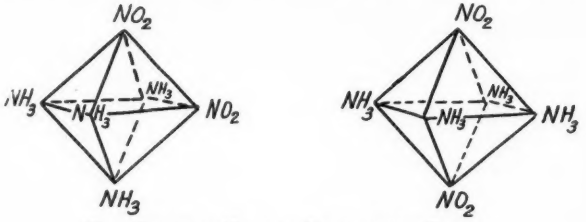
A *B*

It is impossible to isolate either form of the acid, or of its salts. The two isomeric tri-ethyl esters, however, have been prepared (*13*). Formula *A* is indicated by the preparation of phosphorous acid from phosphorus trichloride, formula *B* by the fact that the acid is dibasic. It has been shown (*14*) that when phosphorus trichloride is dissolved in water the solution has much greater reducing power at first than after it has stood for some time. It is concluded from this that a tautomeric change takes place—the symmetrical $P(OH)_3$, formed by the reaction of the PCl_3 with the water, is converted into $HPO(OH)_2$. This substance, in which the valence of the phosphorus is five, does not have the reducing power which is so manifest in its isomer. Still another piece of evidence points toward the existence of two tautomeric forms: the conductivity of solutions of phosphorous acid increases with rising temperature up to about 70°C.; above that temperature, the conductivity decreases again (*15*). Some change in the structure of the solution must take place near 70°C. A great deal of work has been done on the structure of phosphorous acid and more proofs for the existence of the two tautomeric forms might be given (*16*). Sulfurous, nitrous, and other oxy-acids similarly show tautomeric forms.

Optical isomerism is frequently encountered in inorganic chemistry but, for the most part, it is of a different sort than the optical isomerism of organic chemistry. Organic compounds owe their activity to the arrangement of the atoms within the molecule, and as long as the molecule is not disrupted, the activity remains. Some complex inorganic compounds display this type of isomerism, but the activity of the simpler inorganic compounds is due to the arrangement of the molecules in the crystal; fusion, solution, or any other process which destroys the crystalline form also destroys the activity. Crystalline quartz shows a strong rotatory power—a section one millimeter thick, cut perpendicular to the principal axis of the crystal, rotates the plane of yellow (D) light through 22°, and

of blue (G) light, through 43°. Bragg (*17*) has explained this upon the hypothesis that the silicon atoms are in long chains with the oxygen atoms arranged in spirals around these chains; the plane of polarized light is rotated to the right or to the left depending upon the direction of rotation of the spiral. X-ray analysis of the crystal strongly supports this view. Sodium chlorate shows a weaker, but still distinct, rotation; on cooling a saturated solution of this material the two forms crystallize in equal amounts (*18*) unless the supercooled liquid be seeded with a crystal, in which case only crystals of the seed type separate (*19*).

The presence of an asymmetric metal atom in an organic compound makes the compound optically active, just as the presence of an asymmetric carbon atom does. Isomerism of this sort is truly inorganic, for it is due to the inorganic part of the molecule. The best-known optical isomers of



TWO FORMS OF DINITRO-TETRAMMINE-COBALT

this sort are found among the metallo-organic compounds of lead, tin, germanium, and silicon. Organic nitrogen and phosphorus compounds likewise may show optical isomerism due to asymmetry of the quinquevalent nitrogen or phosphorus atom.

The inorganic complex compounds offer an almost unlimited variety of isomers. Many of these are too complicated for consideration in an introductory course, but a few may be mentioned. Hydrated chromic chloride exists in three modifications:

$$[Cr(H_2O)_6]Cl_3,\ [Cr(H_2O)_5Cl]Cl_2(H_2O),\ \text{and}\ [Cr(H_2O)_4Cl_2]Cl\cdot(H_2O)_2$$

The first of these is violet, the other two are green. All of the chlorine in the first compound, two-thirds of that in the second, and only one-third of that in the last, is precipitated by silver nitrate (*20*).

A simple example of stereo-isomerism in inorganic chemistry is dichloro-diammine-platinum, $Pt(NH_3)_2Cl_2$. Two isomers of this compound are known (*21*). Evidently all of the groups lie in one plane, and the formulas are as follows.

There are also many cases of stereo-isomerism among three-dimensional molecules—dinitro-tetrammine-cobalt, $Co(NH_3)_4(NO_2)_2$, is a good example. In this compound, the cobalt atom is supposed to be at the center of a regular octahedron with the other groups at the corners. Two forms are possible, one in which the nitro groups are on adjacent corners, one in which they are on opposite corners. (See page 314 for diagrams.) Both forms are known (*22*).

The inorganic complex compounds show several other types of isomerism, but for the most part they are more complicated than these, and need not be discussed here. The book by Schwartz, translated by Bass (*20*), gives an excellent review of all the types of isomerism of the complex compounds.

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Nothing great was ever achieved without enthusiasm.—ALEXANDER SILVERMAN

A SIMPLE DEVICE FOR ILLUSTRATING ON A PLANE SURFACE THE PROJECTION FORMULAS OF ORGANIC COMPOUNDS

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A simple celluloid stencil of the carbon tetrahedron can be used at the blackboard and in study to build up formulas of the organic compounds. The resulting stereograms develop a mental picture of the spatial relationships in these compounds and thus overcome one of the main difficulties in the teaching of organic chemistry. And the writing of organic formulas becomes an interesting project-problem in place of a memory task. Furthermore, the stereograms are especially useful in the teaching of the Geneva System terminology. The use of the stencil is not limited to mere formulas but easily illustrates during lecture, quiz, or laboratory the principles of free rotation, simple and optical isomerism, cis-trans compounds, and even the cyclo-compounds.

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The tridimensional relationships in the hydrocarbon molecules are easily demonstrated in the lecture room by means of models. However, when the student is preparing his work, or when the instructor has only the blackboard available, stereographic difficulties arise immediately. This problem may be solved and the correct spatial ideas may be imparted if a tetrahedron is constructed; but this is laborious and time-consuming. Another disadvantage in the use of the actual tetrahedron is that confusion results when it is used for the illustration of complicated compounds. Although there have been many attempts (*1*) to represent tridimensional relations of chemical formulas, it seems that so far no attempt has been made to place in the hands of the students themselves a device that would aid in the writing of stereograms.

To fill this need it has been found in actual classroom practice that a simple celluloid stencil can be used. After some experimentation, the size and figure in the accompanying diagram has been found to be the most practicable. However, if larger or smaller stencils are desired, they may be constructed on the principle of similar triangles. The circles representing the carbon and the hydrogen atoms are punched out with an ordinary card punch, and the lines representing the valence bonds may be cut out with a sharp knife.*

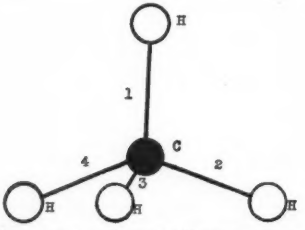
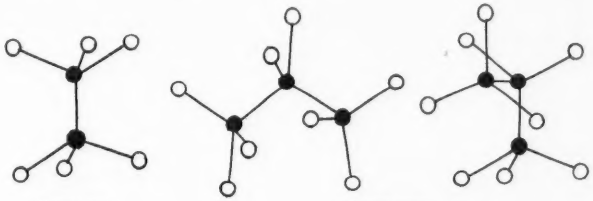


FIGURE 1.—CARBON TETRAHEDRON STENCIL
(actual size for student use)

In using the stencil, the central opening is always retained as the carbon atom and is made solid in the drawings. This easily distinguishes it. For the sake of uniformity in class assignments, the valence

* Prepared stencils may be obtained from Millard Heath Company, St. Louis, Mo.

bonds are always numbered in the same rotation. When formulas are being built up, any one of the four hydrogen atoms may be used as the next carbon nucleus by simply making it solid. With a little practice, any configuration that can be shown by means of the actual models may be illustrated on a plane surface through the use of the stencil.

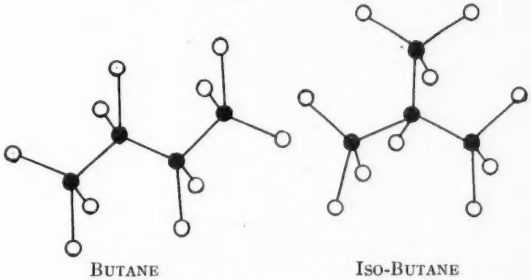


ETHANE PROPANE

FIGURE 2.—TRIDIMENSIONAL FORMULAS BUILT UP BY MEANS OF THE STENCIL

The second figure (of Figure 2) illustrating propane shows a fundamental principle in using the device: matching the valence bonds between the carbon-nuclei. It also shows how the figures visualize the idea of free rotation.

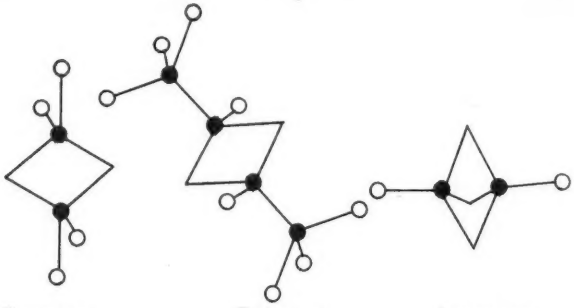
Isomers can be easily illustrated (Figure 3), and by this method their differential tridimensional aspects become part of the mental equipment of the student. Thus one of the great difficulties in the visualizing of organic compounds is overcome. The student unconsciously absorbs the tridimensional picture.



BUTANE ISO-BUTANE

FIGURE 3.—DIFFERENTIAL TRIDIMENSIONAL ASPECTS OF ISOMERS

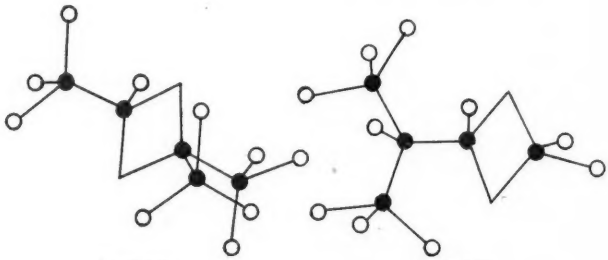
The stencil need not be limited in its use to the simple hydrocarbon compounds nor to simple isomerism. By omitting the circle on two hydrogen atoms and using the end-points as points of contact, not of coincidence, unsaturation of the double and triple bond series can be illustrated (Figure 4).



ETHYLENE BUTYLENE ACETYLENE
(SYMMETRICAL DIMETHYL ETHYLENE)

FIGURE 4.—USE OF THE STENCIL TO ILLUSTRATE THE PRINCIPLE OF UNSATURATION

The two following figures (Figure 5) show the ease of introducing the student to terminology according to the Geneva System; and at the same time, the spatial differences among the compounds is stressed.



AMYLENE
(2-METHYL-2-BUTENE)

AMYLENE
(3-METHYL-1-BUTENE)

FIGURE 5.—INTRODUCTION TO THE GENEVA SYSTEM BY MEANS OF THE STENCIL

Arbitrary symbols may be chosen for halogen, nitrogen, oxygen, carbonyl, etc., groups, and with these the use of the stencil can be extended into the fields of optical isomerism and cis-trans compounds. For instance, the optical activity of lactic acid can be easily correlated with its spatial symmetry, and the optical inactivity of hydroxy-acetic acid is connected at once with the asymmetry of the carbon atom. Again, the differentiation of properties depending on the geometrical relations of the component groups in chemical compounds having identical structural combination, as in maleic and fumaric acids, is visualized clearly as a cis-trans effect through the use of the stenciled figures (Figure 6).

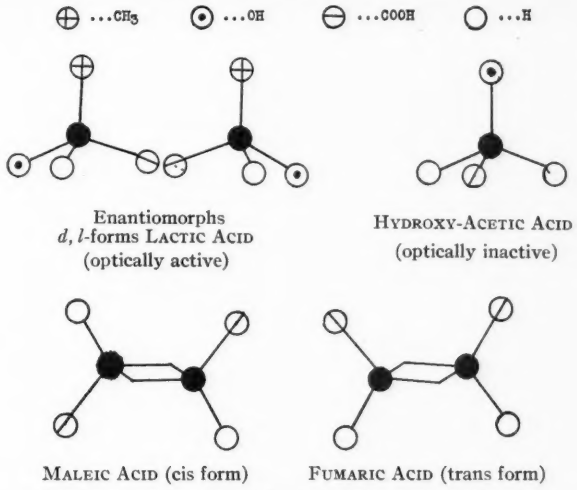


FIGURE 6.—USE OF THE STENCIL TO ILLUSTRATE OPTICAL ISOMERISM AND CIS-TRANS FORMATIONS

There are further useful applications of the stencil if it is placed in the hands of the students during lecture period, quiz, and laboratory. With it any of the characteristic configurations of organic compounds, even those of the cyclo-compounds, can be successfully demonstrated. One of the distinct advantages accruing from its use, aside from the acquiring of the spatial viewpoint, is that it takes the writing of chemical formulas out from the realm of the memory task and gives to it the arousing stimulus of the project method. It is an aid in the two most difficult phases of organic chemistry: the tridimensional relationships and the thorough mastery of the principles underlying formulas.

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Nupercain, New Swiss Local Anesthetic. Studies of a new local anesthetic, nupercain, were reported by W. R. Bond and N. Bloom at the recent meeting in Baltimore of the American Pharmaceutical Association. The new anesthetic was introduced by the Society of Chemical Industry at Basle, Switzerland. It is claimed to be better than cocaine for local use. Pharmacists Bond and Bloom found that it is five times more poisonous than cocaine, but can be used in one-tenth the concentration. It is most efficient as an anesthetic when applied to the cornea of the eyeball.—*Science Service*

GLASS VERSUS SLATE BLACKBOARDS*

FOSTER DEE SNELL AND BEATRICE S. FOX, 130 CLINTON ST., BROOKLYN, NEW YORK

Because of the progressively poorer quality of blackboard slate as the best deposits are exhausted, an alternative is desirable. The defects of natural slate are knots, irregular color due to ribbons, and scratches. Slate requires refinishing after five to fifteen years. Asbestos and pulp bases with emery finishes are unsatisfactory for long-continued use. Sand-blasted glass is either too rough or wears smooth too quickly.

A glass blackboard described consists of a $Na_2O:CaO:6SiO_2$ glass mix colored with manganese and cobalt containing twenty-five to thirty per cent of black chromite suspended throughout the glass while in a molten condition. The abrasive, which can be varied, must be sufficiently harder than glass so that normal wear will not cause it to become smoother than the original. That this result has been obtained is shown by artificial wearing tests with an eraser operated by reciprocating motion to give the equivalent of one hundred twenty-five years' wear without appreciable damage to the writing surface. It is concluded that since a board of this composition is producible in any desired quantity the problem of depletion of the slate supply need not concern the school. The cost of manufacture permits its sale at a price competitive with natural slate. The product is not a "substitute" in the usual use of the term but a material to replace slate which is equal in quality in every way and superior in many.

. . . . . .

The tendency in all branches of science today is to substitute the synthetic and the artificial for natural products wherever possible. Synthetic products can be made exactly according to specification and are therefore more dependable. Where the supply of the natural product is restricted, its quality is steadily deteriorating or its price increasing as the best of it is used up.

Slate, and particularly slate suitable for blackboards, is a natural product of this type for which an alternative is becoming more and more desirable. Substantially all the slate suitable for blackboard use is found in a restricted area in eastern Pennsylvania. While the supply is sufficient for present demands, it is inevitable that the best slate will eventually be exhausted and a new material will be needed to take its place.

One alternative already introduced for slate as blackboards is glass. This is a synthetic, factory-made product, similar to slate in many of its physical properties and one made from raw materials of which there is a plentiful supply. In the past the method of preparing glass for this use has not been sufficiently perfected so that it could compete with natural slate. A method has now been developed which gives a product which may satis-

* Presented before the Division of Chemical Education at the 80th meeting of the American Chemical Society, Cincinnati, Ohio, Sept. 8–12, 1930.

factorily replace slate in every respect and is superior in many characteristics.

Blackboard Slate

The characteristics of slate that make it peculiarly suitable for blackboards are its dense, compact structure and the absence of any absorption at its surface. The average water absorption for clear slate stock after immersion for twenty-four hours is 0.196% (*1*). This dense and non-porous structure enables the slate to be polished to a fine, smooth surface which is particularly adapted to taking chalk marks. Its non-porous nature prevents particles of chalk from clinging to the surface so that it may be easily erased. This material is not markedly affected by heat or cold so that it shows no important expansion or contraction with changes in temperature. It is resistant to the action of all chemicals, as well, so that its wearing qualities are very satisfactory.

Practically all of the slate that is used for blackboards is quarried in Lehigh and Northampton Counties of Pennsylvania (*2*). The particular qualities of this slate are its softness, its dark gray color, its high fissility and its plane or only slightly curved cleavage. The slate is elastic enough so that if the cleavage is not perfectly straight when the slabs are split it can be sprung into position. The slate in this region is particularly dense and uniform in structure. Its appearance under the microscope has been compared with that of high-carbon steel. Layers of this clear gray slate are interspersed with layers of a darker carbonaceous slate. These dark layers are present as ribbons in the clear slate and must be avoided when quarrying for blackboard use. In certain sections of this so-called Blue Mountain district in Pennsylvania the clear slate is taken out in large pieces and is used exclusively for blackboards. The clear stock, however, comprises only about twenty per cent of the extracted slate. Due to its scarcity and the necessity for care in selection and cutting out, its price is from twenty-five to thirty per cent higher than the ribbon stock (*3*).

The following process is carried out in making up the slate into blackboard (*4*). The slate is taken out in huge blocks and hauled to the mill. There it is steel-sawed into two or three pieces. These pieces are trimmed and squared by steel saws to the required length and width. They are then split into about one-half inch sheets by a professional "splitter," who must be able to recognize the grain in slate as easily as a carpenter does in wood. The splitting is done with chisels or wedges. A sheet of slate so obtained is next treated to obtain a finished surface. It is sand rubbed on a revolving rubbing bed and then given a "honed" surface, which is obtained by polishing with round, flat abrasive stones in the presence of a steady stream of water. This gives the "velvet" finish which is so desirable.

The importance of the use of slate for blackboards may be shown by the following figures. In 1928 the total value of the slate sold by producers

in the United States was $11,472,291. Of this the value of the slate sold for blackboards and bulletin boards was $1,079,452 (5). The latter amount was the value of 3,713,840 square feet of slate at the quarry. From these figures, approximately one-tenth of the value of slate quarried is for blackboard purposes.

The properties of slate outlined above had made it the standard material for blackboards and it is recommended by most architects and state authorities in building public schools. Since slate has been used for this purpose only a comparatively short time the very best quality of slate has been available. As this very fine slate is used up, however, and it becomes necessary to select pieces which are not so free from blemishes, the faults inherent in a natural product occurring in a restricted area become evident. Very few pieces of slate have a perfectly uniform surface. Even on the best pieces there is some irregularity in the grain and small spots or markings are evident on close inspection. The finishing process also leaves very fine scratches which become more noticeable after long use. These blemishes are, of course, present in greater quantity in the poorer slate that must be used after the best pieces have been selected. The cleavage of the slate cannot always be depended upon to be perfectly straight so that pieces are often obtained which vary in thickness from one-sixteenth to one-eighth inch from one end to the other.

One of the qualities of slate that recommends itself most strongly is its permanence. It is, of course, extremely resistant to wear but in spite of this fact it cannot be used continually in the schoolroom without further attention after it has been set up. After a period of five to fifteen years, depending on the amount of wear, the surface requires refinishing. This is because it is stained or given an oil finish to make the color darker and blacker. This finish eventually wears off leaving the lighter gray color of the natural slate. Continual erasure and washing of the boards also tends to intensify the slight scratches that are present originally, so that the surface is considerably roughened in time.

Alternative Blackboards

Substitutes for slate have been developed for varying reasons. A number of cheaper products are sold which do not have the lasting qualities of slate nor as fine a surface. These consist principally of some cheaper material such as a wood pulp or asbestos composition which is given a surface coating of emery and adhesive to imitate slate. This surfacing is applied to cloth for very cheap blackboards that will not receive much wear.

Alternatives have also been marketed which are designed to eliminate the disadvantages inherent in a natural product and yet retain the advantages of slate. Such a product should be uniform in composition and

easily manufactured to meet any specifications. Economy would not be as important a consideration here as the board would be designed to have better lasting qualities than slate as well as other advantages of an artificial product. The material uniformly used for a blackboard of this nature has been plate glass. This is a siliceous material very similar to slate in weight, in hardness, in compact structure, and in porosity. It may be manufactured to any size or thickness desired and is of entirely uniform composition throughout.

The surface of plate glass, of course, will not take a chalk mark and some treatment is necessary before it can be used for writing purposes. Until recently no treatment had been devised which would give glass a writing surface comparable to that of slate in both smoothness and durability. Mud blasting gives a satisfactory surface but after five or ten years' wear this surface wears off due to the action of constant erasing and washing. The shiny, smooth surface of the glass is then unsatisfactory and the board must be refinished. If a more drastic treatment is used the writing surface lasts longer. Sand blasting has been used in some cases. This gives a more durable surface but it is correspondingly rougher so that it is unpleasant for writing and very difficult to erase and keep clean.

The dark color necessary for a blackboard is obtained with glass either by superimposing the colorless glass on a black background or by coloring the glass itself. A very deep black glass may be obtained, as demonstrated in black glass table tops and other articles made of that material.

Development of a Permanent Glass Blackboard

The problem to be overcome in developing an artificial slate blackboard was therefore one of further developing the use of glass by treating it in such a way that it could be given a surface as fine and velvety as that of slate, and which would at the same time be perfectly durable.

The method adopted was to incorporate a fine abrasive in the glass mix. When perfectly distributed throughout, the presence of this material would give a writing surface, the roughness of which would be dependent on the coarseness of the abrasive. Being uniformly distributed throughout the glass it would also insure a permanent writing surface since no matter how far the glass may be worn the surface would always be the same. The abrasive added must not react with the glass in the melting process and must differ sufficiently in hardness from the glass so that the surface will not wear smooth.

Abrasives that seemed promising for the purpose were tried out in laboratory mixes. The formula used for the glass base was sodium oxide, calcium oxide, and silica in a 1:1:6 ratio. Among the addition agents tried out were fine iron filings, powdered chromite, alundum, carborundum, and pumice. These were unsatisfactory in the first experiments, either be-

cause of reaction with the glass or inability to mix well, with the exception of the chromite. The latter seemed very promising both as to its inert nature toward the glass mix and its miscibility.

A glass mix containing approximately twenty-six per cent chromite and four per cent pyrolusite was made up on a larger scale. The chromite used in these preliminary experiments was an 80-mesh grade or coarser. The samples produced showed even dispersion of the chromite throughout the glass on examination of the fracture. The rough surface of the fracture took chalk well and erased easily. This formula was therefore adopted as the basic composition for a glass blackboard.

Further experimental batches were run on semi-plant and plant scales in order to determine what materials were necessary to give the proper shade and degree of blackness and the desired velvety texture. The early batches, in which pyrolusite was used with chromite to give opacity, were a brownish black. Other materials of approximately the same hardness and density were tried as substitutes for the chromite in order to improve the color. Rutile and illmanite were not entirely satisfactory.

The use of magnetite seemed promising in laboratory mixes but gave too light a color in larger scale batches. The difficulties were eventually overcome by use of a black chromite, a much finer grade than the 80-mesh grade giving a better texture. A grading of ninety-nine per cent through 100-mesh, ninety per cent on 200-mesh, was adopted as best. The color was further improved by the addition of a small percentage of cobalt oxide.

In adopting this commercially, the ingredients are mixed in the glass melt and the procedure for making plate glass followed from that point on.

The surface of glass of this composition after rolling is glossy. The concentration of chromite particles in the actual surface is very low, although immediately under the surface they are well dispersed. It is therefore essential to remove this surface, both because of its imperfections and because of its smooth texture. The usual plate glass procedure of first "polishing" with coarse sand, then with fine sand, and last with rouge gives, as anticipated, instead of a smooth glossy surface, a velvety one similar to slate. The similarity of this procedure to that of finishing slate is also worthy of a passing mention. This velvety texture cannot be destroyed or a glassy surface obtained by further polishing with rouge.

Wearing Tests and Comparison with Slate

Since the desired feature of an artificial slate blackboard was durability, a test was devised to show how the glass containing suspended abrasive would stand up under constant wear. The following procedure was designed to simulate as closely as possible the actual conditions of wear to which a blackboard is exposed.

An ordinary blackboard eraser was mounted on a shaft operated by a

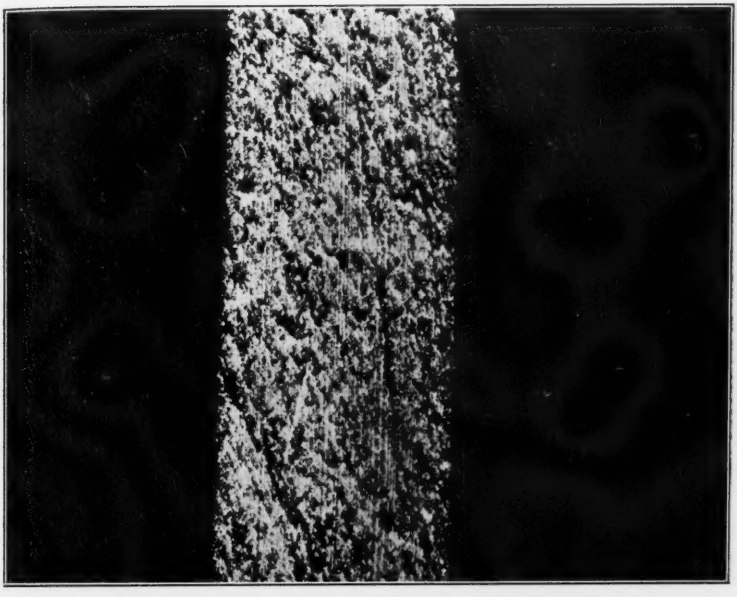


FIGURE 1.—CHALK MARK ON SLATE 6×

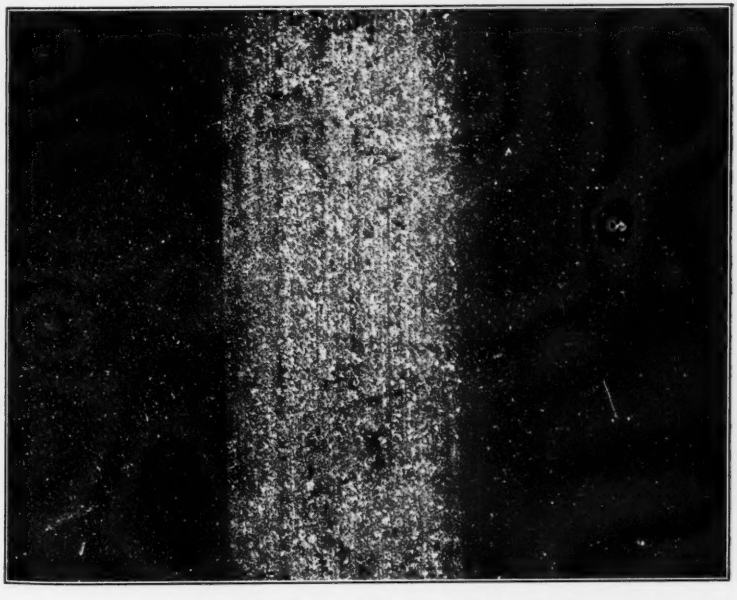
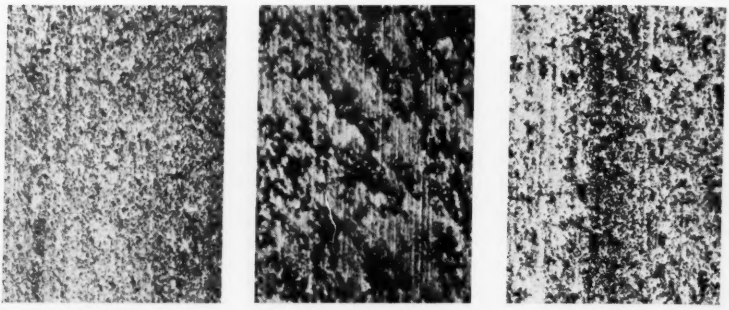
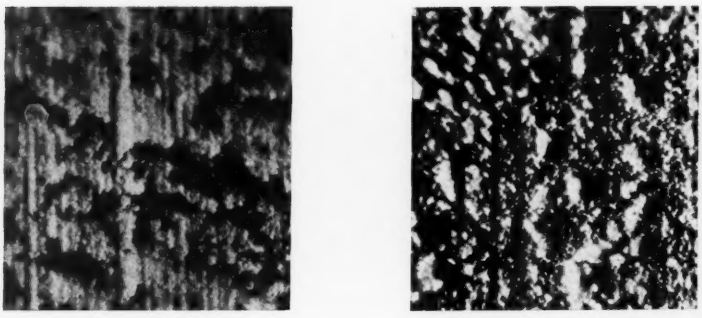


FIGURE 2.—CHALK MARK ON SELOC GLASS 6×



Seloc Glass 9× | Slate 9× | Worn Seloc Glass 9×



Seloc Glass 30× | Slate 30×

FIGURE 3.—CHALK MARKS ON SLATE AND SELOC GLASS

quarter horsepower motor with a reciprocating motion. The speed was controlled to give thirty cycles per minute. The eraser used was six inches long by two and one-quarter inches wide. The length of the stroke was twelve inches. The wearing element, in this case the eraser, floated freely and could be loaded with any desired weight. For these tests a weight of two kilograms was used.

The blackboard to be tested was mounted on a cloth pad and covered with a liberal supply of precipitated calcium carbonate or calcium sulfate to correspond to the abrasives which wear down the surface in actual use. The chalk was removed from time to time and a fresh supply added.

Assuming that a blackboard in school use is erased ten times a day, gone over twice each time, and that the school is in operation five days a week for fifty weeks of the year, the board will receive eight hundred lineal feet of wear per year. In the tests made, any one spot on the blackboard was

brushed by eighteen hundred lineal feet of eraser per hour. An hour's erasure in this manner therefore corresponded to something over two years of actual service. The machine was operated for a total of sixty-two hours in one test. This would compare with approximately one hundred twenty-five years of service.

Such tests on the glass board, made commercially according to the composition developed as above, show the results expected. After approximately one hundred twenty-five years of service, this type of blackboard will still take chalk as readily as when new. In contrast with slate this long period of wearing does not lighten the color. Fading cannot occur since the color is uniform throughout.

In obtaining a surface on glass that will not be destroyed by wear, it was also desirable to obtain a surface that will be as fine and velvety as that of slate. By the use of a closely graded abrasive this is possible. In fact, the writing surface of this glass is superior to that of slate in that it is perfectly even and free from irregularities, markings, or scratches. Photomicrographic comparisons of chalk marks are difficult because of the physical variations in the pressure used, depth of the marks when so viewed, and variations in lighting. With these expressed limitations Figures 1 and 2 (page 325) show chalk marks on the two at six times magnification to give details of texture. The glass gives a mark of much finer texture and is more sharply defined. The slate shows scratches even at that magnification, such scratches being due to the softness of the slate. The slate used was a sample piece selected as being unusually good. The scratches shown are macroscopic.

Figure 3 (page 326) shows microscopic comparisons of smaller areas at nine times magnification, including a worn sample of glass. Further detail is shown in thirty times magnification of the glass and slate. In these the difference in the marks is clearly brought out as the projections on the glass are small, taking small particles of chalk while the particles of chalk on the slate are much larger.

The glass board is approximately the same thickness, weighs the same per square foot, and is erected in exactly the same way as slate.

The results presented in this paper are published by permission of the New York Silicate Book Slate Co., 20 Vesey Street, New York City.

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(2) CHARLES H. BEHRE, JR., "Slate in Northampton County, Pa.," Pennsylvania Geological Survey, Fourth Series, *Bull.* **M9.**
(3) Ref. (*1*), p. 10.
(4) "Natural Slate for Blackboards," Natural Slate Blackboard Co., **1920,** p. 4.
(5) OLIVER BOWLES AND A. T. COONS, "Slate in 1928," *Bureau of Mines Bull.,* Mineral Resources of the U. S., **1928,** Part II, **1929,** p. 45.

THE SECTIONING PROBLEM IN GENERAL CHEMISTRY*

A. J. CURRIER, THE PENNSYLVANIA STATE COLLEGE, STATE COLLEGE, PENNA.

Data obtained from examinations, designed to test previous training in high-school chemistry and aptitude for the study of chemistry, given in September, 1929, to freshmen matriculated in four technical schools (agriculture, chemistry and physics, engineering, mineral industries) of The Pennsylvania State College are used to show the status of the training in high-school chemistry and in arranging "A" sections in general chemistry given in the first semester. The results of these examinations are compared with the results obtained at the completion of the course of the first semester. Conclusions are summarized.

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The organization of courses in general chemistry in such a manner that each student may receive the maximum benefit is an extremely complicated problem, particularly in the larger institutions. Many studies have been made in connection with this problem. [See references (*1*) through (*9*) on page 330.]

A number of the larger institutions have found it advisable to differentiate their students in general chemistry on the basis of previous training in high-school chemistry. Many others have not. Administrative factors such as the method of determining previous training, credits to be given, laboratory accommodations, etc., have had considerable bearing, of course, on the policy adopted in the various institutions. It seemed to us that the aptitude of a student for the study of chemistry is a factor worthy of consideration, although it is a trait which is difficult to evaluate by tests.

In the fall of 1929 we undertook to obtain definite information concerning the following points:

1. The status of the high-school training of our freshmen.
2. Their aptitude for the study of chemistry (as nearly as could be shown by our tests).
3. A plan for sectioning these students in general chemistry based on results obtained from tests.
4. The relation between final results obtained in general chemistry and previous training and aptitude.

For the purpose of our study, brief, mimeographed examinations of two types were given to freshmen during "freshmen week" at the beginning of the semester. One, the "Training Test," was designed to cover the important phases of the high-school chemistry. The other, the so-called "Aptitude Test," included questions requiring calculation and reasoning similar to that employed in general chemistry. Our "A" sections were, in general,

* Presented before the Division of Chemical Education, at the 80th meeting of the American Chemical Society, Cincinnati, Ohio, Sept. 10, 1930.

made up of students who had earned a grade of 70% or more either in the "Aptitude Test" or the "Training Test." It was thought that students with a high "aptitude" standing should be able to do superior work even

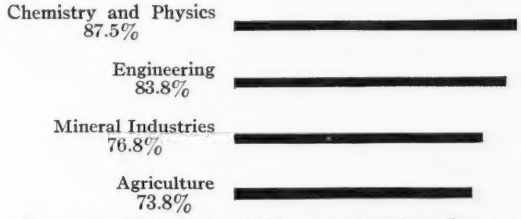

FIGURE 1.—PERCENTAGE OF FRESHMEN IN FOUR SCHOOLS OF THE PENNSYLVANIA STATE COLLEGE WHO HAD HIGH-SCHOOL CHEMISTRY (TOOK TRAINING TEST) (1929)

though they had not previously studied chemistry. The results obtained in these tests and the final grades for the course are summarized in Figure 1 and in Tables I and II.

TABLE I

General Classification (Chemistry 1 and 3)

	Number Who Took Test		*Number Who Failed Test*		*Number Who Failed Course*	
Aptitude Test*	104		49		40	
		13%		48%		39%
Training Test**	516		234		68	
		66%		45%		13%
Neither Test†	154		...		27	
		20%				17%
Total	774		283		135	
						17%

* Taken by students who had not studied chemistry in high school.
** Taken by students who had studied chemistry in high school.
† Taken by students who registered late, sophomores, juniors, and seniors.

TABLE II

"A" Sections vs. Regular Sections (Chemistry 1 and 3)

A SECTIONS

	Number Who Took Test	*Number Who Failed Test*		*Number Who Failed Course*	
Aptitude Test	34	3*		12	
			9%		35%
Training Test	137	7*		8	
			5%		5%
Total	171	10		20	
			6%		12%

REGULAR SECTIONS

	Number Who Took Test	*Number Who Failed Test*		*Number Who Failed Course*	
Aptitude Test	70	45	60%	28	40%
Training Test	379	228	60%	60	16%
Total	449	273	61%	88	20%

* It was necessary in Chemistry 3, to include students with less than 70% grades in the tests in order to make full sections.

Conclusions

1. Of the students who entered four technical schools of The Pennsylvania State College in 1929, those in the School of Chemistry and Physics ranked the highest in relative percentage who had high-school chemistry. Students in the School of Engineering ranked second, in the School of Mineral Industries third, and fourth in the School of Agriculture.

2. The number of failures in general chemistry in college is three times as great (39%:13%) among those who did not have high-school chemistry as among those who did have it (Table I). In the "A" Sections (Table II) this ratio is even more striking (35%:5%). It follows that the student who had studied chemistry in high school had a decided advantage over the one who did not.

3. Results obtained in our training tests formed a sound basis for the selection of students for "A" Sections.

4. Results obtained in our aptitude tests did not form a sound basis for the selection of students for "A" sections (excepting those with very high grades, 90% or above, in these tests).

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THE LOW STUDENT IN GENERAL COLLEGE CHEMISTRY

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The results of an organized review course for students, conditioned in general college chemistry, from the schools of agriculture, pharmacy, chemical engineering, and mines are given. This low group of students was approximately sixteen per cent of two hundred students taking the chemistry course.

The purpose of the review course and the method of conducting the review are described. Data submitted indicate that:

1. Sixty per cent of the conditioned students enrolled in the organized review class.

2. Over ninety-five per cent of those in the class were successful in the removal of the conditional grade.

3. Twenty per cent of the students made no attempt to improve their standing and were failed.

4. The remaining twenty per cent of the students organized and conducted their own review, and of these, approximately two-thirds passed the conditional examination.

An analysis of the subsequent work of conditioned students who passed the "make-up" examination revealed a quality of work which remained inferior.

. . . . . .

This paper considers the problem of the low student in general college chemistry, giving data relating to an attempt to assist him by offering thoroughly organized review class work.

For a number of years a system of grading was employed at Oregon State Agricultural College in which a conditional grade of *E* was given to students who, presumably, were too good to be failed and too poor to be passed. This grade was converted to a passing grade of *D*, or to an *F*, or failure based entirely upon the result of a second written examination given a few weeks after the beginning of the next term's work. When such students were re-examined, it was often found that their knowledge of the subject was practically the same as it had been at the time the conditional grade was received. These students, being scheduled with regular class work, generally conducted a review which was hurried and poorly organized. As a result, their minds were crammed with confused and undigested facts and principles. Instructors evidently had merely postponed their decisions concerning the students' final grades.

In order to obviate poorly conducted review on the part of the individual student, arrangements were made and followed for a number of years, in which thoroughly organized review courses were offered, for a small charge, to those choosing to enrol. The real purpose of the review was not merely to give those attending sufficient facts to enable them to pass successfully the "make-up" examination, but rather to ground them

adequately in the fundamentals and principles of chemistry so that they could, with profit to themselves, pursue subsequent chemistry courses. Should these hopes be realized, it would be expedient to include in the group some of the better *F* (failing) students and some low *D* students.

Experienced instructors conducted the review courses. The methods employed were left in their hands. Fifteen to twenty hourly periods were scheduled. Each period covered a definite assignment and was given over to explanation, oral and written recitation, drill at the board, the answering of questions, and assignment for study.

Table I summarizes grades given during one year (1926-1927) to general chemistry students from the schools of agriculture (100 students), pharmacy (77 students), chemical and mining engineering (59 students).

It will be observed from Table I that the number of *E* (conditioned) students averaged sixteen per cent. During the spring quarter the number was considerably lower.

TABLE I

Grade Summary of General Chemistry College Students

	Number	% *A* (93–100)	% *B* (85–92)	% *C* (78–85)	% *D* (70–77)	% *E** (60–70)	% *F* (0–60)	% *Drop*
					16.5		12.3	
Fall quarter	236	14.0	16.5	21.6	28.4	15.7	16.1	3.4
					19.1		6.4	
Winter quarter	188	12.0	18.0	18.0	35.6	23.4	13.3	3.0
					22.0		3.0	
Spring quarter	153	14.0	24.0	29.0	30.0	9.0	4.0	0.0
					19.2		7.2	
Average	192	13.3	19.5	22.9	31.3	16.0	11.1	2.1

* A temporary grade changing later to *D* or *F*. It is with this group of students that this paper deals.

Table II gives data relating to the organized review for the *E* or conditioned students.

It will be observed from Table II that approximately sixty per cent of the *E* students enrolled in the organized review class; that over ninety-five per cent of those enrolled successfully removed the conditional grade. Of the remaining forty per cent, nearly half conducted their own review and attempted the "make-up" examination. Two-thirds of these students passed the examination, the remaining twenty per cent were failed automatically, since they made no attempt to change their standing.

If making a passing grade following the organized review is to be the sole standard for judgment, the plan is an unqualified success. However, we should also consider the subsequent work of these students in order to determine whether the review courses gave them sufficient assistance to enable them to continue creditably.

TABLE II

The Change of the *E* Grade to Failure or Passing

A comparison of those who enrolled in the review class with those who did not.

	Fall Quarter	*Winter Quarter*	*Spring Quarter*	*Summary for Year*
Number of *E* students	37	44	14	95
Number in review class	19	27	9	55
Number in review class passing examination	18	26	9	53
Number of *E* students not in review class who attempted examination	12	9	1	22
Number not in review class, passing examination	8	5	1	14
Number not taking review or examination	6	8	4	18

Table III indicates the quality of subsequent work of *E* to *D* students.

It will be seen from Table III that but two students of the first term *E* to *D* group made a passing grade of *D* during the second term. None made a grade of *A*, *B*, or *C*. Certainly, the quality of work of these students leaves much to be desired. In general, it appears that a low student in chemistry remains low in spite of all that can be done to assist him. Some may contend that this type of student would better be failed outright: a policy which would lessen the output but increase its quality.

TABLE III

Subsequent Work of the *E* to *D* Students

	2nd Quarter Work of First Quarter E to D Students	*3rd Quarter Work of Second Quarter E to D Students*
Number who enrolled	24	31
Quality of work: *A* grades	0	0
B grades	0	2
C grades	0	3
D grades	2	12
E grades	17	13
F grades	5	1

After considering these data, the policy of this department changed, and, while the organized review course for *E* students was continued, the number of students was reduced to a minimum. This was accomplished by failing the more doubtful students at the close of the quarter, and by allowing low *D* grades to remain as such. However, subsequent data, not included in this paper, indicate but slight differences from those which have been supplied. Since the fall of 1929, a system of grading has been employed at this institution which eliminates the *E* grade, thus terminating our task of providing the organized review course.

Patience is a necessary ingredient of genius.—DISRAELI

A STUDY OF THE NEED FOR JUNIOR LABORATORY TECHNICIANS IN THE CHEMICAL INDUSTRY OF ESSEX COUNTY, NEW JERSEY

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The study was undertaken to determine the need for this type of employee and provide a basis for organizing a training program to provide industry with properly trained recruits. The questionnaire method was used to secure the desired information which included the demand for junior workers, preferable age for employment, required academic background, initial salary, personal qualifications, and duties. Along with the questionnaire a personal interview of twenty-five per cent of all the firms approached was also made. From the information gathered by the procedure indicated, the need for the training was shown and the subject matter for the proposed course of training was secured. This subject matter is of course merely an experimental beginning.

The latter portion of the paper criticizes somewhat the demand on the basis of formal discipline, of certain employers for high-school boys and points out the limitations and inadequacy of the chemical training to which those boys are exposed in the high school. The philosophy of formal vocational education of less than college grade is briefly outlined and a criticism of the lay theory that vocational educational institutions are reformatories is made with some substantiating evidence to offset that theory.

. . . . . .

In 1922 with the removal of the Boy's Vocational School from its first location in one of the old Newark schools to a new, modern building at Sussex Avenue and First Street, in the same city, facilities were provided for the inclusion of a course in industrial chemistry. The facilities consisted of a laboratory with locker and drawer room for one hundred eight pupils and a lecture room capable of seating about forty-eight to fifty-four students. While the laboratory provided locker and drawer storage for one hundred eight students, only thirty-six could work there comfortably at any one time. The equipment which went with this teaching space was the usual type of laboratory equipment found in the conventional high school.

Just why this course was included among the trades offered the boys of Newark in this school, the writer has not been able to discover. Apparently no study of community needs had been made and certainly no consideration had been given to the industrial needs to which this course supposedly catered. The instructor was a capable teacher but with apparently no industrial experience. This in itself would have been a serious error under a progressive vocational program but probably was not so bad under the then existing conditions of a vocational school operated by a conventional, traditional public school board. Needless to say the course did not function. The turnover in pupil enrolment was high. The

boys did not find employment. It is not the purpose of this article to consider the factors governing that condition; I intend only to show the type of organization existing when in January, 1925, this school was transferred to the Essex County Board of Vocational Education.

This Board was organized under the New Jersey law granting the counties right to administer vocational education under the Smith-Hughes Act. This writer was engaged in March of that year as an instructor in related science. The course in industrial chemistry was continued. In March, 1926, the writer was transferred to charge of the Industrial Chemistry Department, superseding the former instructor who was transferred to other work.

Before continuing further I want here to voice my objections to the title of the course. It is a misnomer. A course in industrial chemistry as understood by those of us in the profession is a study of existing chemical manufacturing processes. While there is a certain amount of such knowledge to be included in the course as we present it, nevertheless, fundamentally the course is designed to train junior laboratory technicians or, more commonly, laboratory boys. As I conceive the course, its title should be "Junior Chemical Laboratory Technicians." This title, too, may be open to criticism but again this article does not propose to discuss that.

An expert witness in a court of law must prove his right to give testimony. May I diverge here to prove my right? I was graduated from Columbia University with the class of 1914 with the degree of B.S. in chemistry. For the following eleven years I practiced that profession, always in the research field. That practice included various phases of industrial development of which seven years was in executive operation. During this time I was constantly training young boys on the job as junior laboratory technicians. Not only was I training such help but I was also observing, unconsciously it is true, their training by others. For the last three years of this eleven-year period I was consulting and advising in various lines. This entire training was sufficiently varied and comprehensive to give me a good knowledge of general laboratory practice and requirements.

With this background of industrial experience I was able during the year preceding my appointment to the chemistry department, to observe its shortcomings and to arrive at a temporary idea of the necessary theoretical changes needed to make it function. I discarded entirely the existing course which was basically theoretical and substituted such training as my experience indicated would be necessary to prepare the student for employment. This training was as practical as a school laboratory would permit. It was essentially manipulatory in nature.

While this procedure tended to correct an existing intolerable situation,

scientifically it was worthless. I personally felt that there was need for such training as we proposed to give. I had had sufficient contact with junior laboratory employees in industry to know what was expected of the new boy in the laboratory. However, I had no data to substantiate my beliefs. They were just personal opinions. I felt we were not justified in including in our work the course in industrial chemistry unless such training would provide employment for the boy, and if the course was included then the subject matter of that course should be such as would better equip the student for his later work in industry. The course should not be the result of personal opinion, it should be what the industries in the county require.

Two problems presented themselves. The first of these was: is there need for the training of junior chemical laboratory technicians in the section our schools serve? The second problem resulted from the first: if this training would serve industry and provide employment for our boys, what should be included in such a course of training?

To obtain the information needed to answer the two questions which have been raised, the Junior Employment Service of Essex County was asked to coöperate in a survey of the chemical industry in the county. This was done because of their interest in placement work and guidance and because of that work they were in close contact with industry and so more likely to receive consideration than an individual would be.

We planned to use a short questionnaire, and along with this a personal interview of about twenty-five per cent of the firms. The Newark Chamber of Commerce provided us with a list of sixty-one chemical firms in the section. This list included, with the name and address of the firm, the name of the man responsible for or interested in the employment of junior help. This was important since it meant our investigation reached the man who would be interested in what we were undertaking and would not get into the hands of others not directly interested and so be side-tracked and lost. That this policy was wise is attested to by the fact that of the sixty-one questionnaires either sent or taken out, forty or sixty-five and six-tenths per cent were returned. This is a high return from a survey of this type.

Our first step in the survey was the preparation of the questionnaire. The first draft of this was thoroughly criticized in conference with Mr. R. W. Kent, our assistant director, and members of the employment service. Our aim was to prepare a questionnaire which would secure all the information necessary to guide us intelligently and yet be sufficiently short and concise so as to hold the interest of the busy executive to whom it was to be sent. Along with the questionnaire a short explanatory letter was mailed. The letter and questionnaire follow.

ESSEX COUNTY JUNIOR EMPLOYMENT SERVICE

Dear Sir:

The Essex County Vocational Schools are in the process of revising their course of study in Industrial Chemistry. This course is designed to train students to qualify as laboratory helpers or laboratory boys—*not professional chemists.*

The attached questionnaire is being sent out at the request of Mr. Herman Ernst, chairman of the Committee on the Revision of the Industrial Chemistry Course.

The recommendations and advice of men in industry are sought in order that the training in this department may be practical and that the graduates may measure up more fully to the requirements of junior laboratory aids.

For your convenience we are enclosing an addressed stamped envelope. Your answers can be written directly upon the questionnaire.

Thanking you for your coöperation, I remain,

Very truly yours,
Supervisor

Questionnaire Relating to Training Course for Junior Laboratory Helpers in Industrial Chemistry

Note: We shall appreciate your reply to as many of the following questions as you may be interested in answering. Your recommendations and suggestions will be treated confidentially.

.....

1. Is your organization interested in young men of less than college grade as junior laboratory helpers?.....
2. What is the minimum age at which you employ a junior laboratory helper?.....
   What minimum education in addition to his special laboratory training would you require?
   Grammar School.....
   High School—1, 2, 3, or 4 years.....
3. What particular personal qualifications are desirable in junior laboratory helpers?
   .....
4. In your opinion is the supply of qualified junior laboratory helpers
   In excess.....
   Adequate.....
   Inadequate.....
5. Do you wish a copy of the summary of this questionnaire?.....
6. Under normal business conditions approximately how many of the following are employed in your firm?

	No.	*Approximate Weekly Salary*
Junior laboratory helpers	.....	.....
Junior chemists—college grade or equivalent	.....	.....
Senior chemists—college grade or equivalent	.....	.....
Women chemists and laboratory aids	.....	.....

(*This particular information will be helpful in the vocational guidance work of the schools.*)

7. Kindly check on the attached sheet those duties required of laboratory boys in your type of industry. If all duties are not summarized, please add your suggestions to list.

Possible Duties of Laboratory Boys

Check Here		Check Here	
	1—Clean apparatus		23—Use separatory funnel
	2—Set-up apparatus		24—Use Orsat apparatus
	3—Take samples		25—Use analytical tables
	4—Prepare samples		26—Calculate stoichiometry
	5—Standardize solutions		27—Use chemical handbooks
	6—Weigh on analytical balance		28—Use corrosive chemicals safely
	7—Weigh on balance to 0.02 g.		29—Make fusions
	8—Make precipitations		30—Make up to volume and take aliquot part
	9—Make filtrations		31—Use inflammable chemicals safely
	10—Make evaporations		32—Make ignitions
	11—Make distillations		33—Take specific gravity
	12—Grind samples		34—Determine moisture
	13—Titrate acids and bases		35—Determine viscosity
	14—Titrate—oxidizing and reducing		36—Determine flash point
	15—Titrate—precipitation and iodimetrical		37—Determine melting point
	16—Use oil bath		38—Determine freezing point
	17—Use sieves		39—Determine boiling point
	18—Use electric oven		40—Match colors
	19—Use hot plates		41—Test water
	20—Use Buchner funnel		42—Measure time, stopwatch
	21—Use siphon		43—Measure temperature
	22—Make qualitative tests		44—Use miscellaneous tools, handyman

Kindly Check Below the Classification to Which Your Industry Belongs:

Check Here		Check Here	
	1—Electrochemistry		7—Paints, varnishes, and lacquers
	2—Photography		8—Leather
	3—Analytical		9—Rubber
	4—Metallurgical		10—Molded products
	5—Coal-tar, petroleum, and asphalt		11—Fats, oils, and waxes
	6—Dyes and intermediates		12—Celluloid and paper

FIRM.....

QUESTIONS ANSWERED BY.....

TITLE.....

Before this questionnaire was mailed, fourteen personal visits were made. This number represents twenty-three per cent of all the firms included in the study. The firms visited were selected at random from the list sent us by the Chamber of Commerce. Our only control over this phase of the investigation was to select firms from the different main divisions of the industry as, for example, coal-tar dyes (and intermediates), paints and varnishes, etc. The distribution of industries in the vicinity is diversified.

Of the fourteen firms visited, only seven were interested and answered our questionnaire. These seven were included in the summary of the survey as prepared for study.

After allowing four weeks for all questionnaires to be returned, the following summary was prepared.

Summary of Replies to Industrial Chemistry Questionnaire

Number sent out.....61
Number returned..... 40 = 65.6%

1—Is your organization interested in young men of less than college grade as junior laboratory helpers?

Yes.....	28 = 70% of returns
No.....	12 = 30% of returns

(*In the rest of this summary we consider only those who are interested*)

2—What is the minimum age at which you would employ a junior laboratory helper? What minimum education in addition to his special laboratory training would you require?

15.....	1	Less than grammar school.....	1
16.....	13	Grammar school.....	8
17.....	7	High school—1st year.....	6
18.....	6	2nd year.....	7
19.....	1	3rd year.....	1
		4th year.....	5

3—What particular personal qualifications are desirable in junior laboratory helpers?

Interested	Studious	Inquisitive
Cleanliness	Clean-cut type	Investigative
Steadiness	Honest	Ability
Reliable	Loyalty	Enthusiasm
Dependable	Appearance	Desirable personality
Tidy	Wants to learn	Adaptable
Neat	Ambitious	Veracity
Exactness	Desire to advance and study	Follow instructions
Accuracy	Capable of development	Good moral character
Careful	Polite	Quiet
Conscientious	Diligent	Good health
Thorough	Willing to work	Young
Serious	Energetic	Satisfied to advance gradually until mature enough for foreman, etc.
Respect for authority	Industrious	
Punctual	No clock watcher	

4—In your opinion is the supply of qualified junior laboratory helpers in

Excess.....	1 = 3.5%
Adequate.....	7 = 25.0%
Inadequate.....	18 = 64.3%
Not answered.....	2 = 7.2%

5—Do you wish a copy of the summary of this questionnaire?

Yes.....	18
No.....	10

6—Under normal business conditions, approximately how many of the following are employed in your firm?

	Number	Beginning Wages	
Junior laboratory helpers, several not answered	82	$13.00–$20.00...	13
		$20.00–$35.00...	5
		Weekly	
Junior chemists–college graduates, several not answered	23	$25.00–$50.00 Weekly	
Senior chemists–college graduates, several not answered	60	$40.00–$100.00 Weekly	
Junior and senior chemists, grouped	30	.....	
Women chemists, several not answered	12	$30.00–$50.00	

7—Possible Duties of Laboratory Boys

No.	Duty	Frequency	No.	Duty	Frequency
1	Clean apparatus	25	27	Make evaporations	15
2	Take samples	23	28	Use qualitative tests	15
3	Prepare samples	23	29	Use separatory funnels	15
4	Use electric oven	22	30	Use analytical tables	15
5	Take specific gravity	22	31	Determine melting point	15
6	Grind samples	21	32	Determine boiling point	14
7	Use hot plates	21	33	Titrate, oxidizing and reducing	14
8	Determine moisture	21	34	Make to volume and aliquot	13
9	Weigh on analytical balance	20	35	Use chemical handbooks	12
10	Measure temperature	20	36	Determine freezing point	12
11	Set-up apparatus	19	37	Standardize solutions	11
12	Use corrosive chemicals safely	19	38	Make precipitations	11
13	Use inflammable chemicals safely	19	39	Use miscellaneous tools	11
14	Match colors	19	40	Titrate, precipitation and iodimetric	9
15	Measure time, stopwatch	18	41	Make fusions	9
16	Weigh on balance to 0.02 g.	18	42	Calculate stoichiometry	7
17	Titrate acids and bases	18	43	Test water	6
18	Use sieves	18	44	Use Orsat	5
19	Determine flash point	18	45	Make tests on molding sands	1
20	Determine viscosity	18	46	Use Riehle testing machine	1
21	Make distillations	17	47	Use Brinell hardness machine	1
22	Use oil-bath	17	48	Electrical analysis measurements	1
23	Use Buchner funnel	16	49	Glass blowing	1
24	Use siphon	16	50	Color tinting	1
25	Make ignitions	16			
26	Make filtrations	15			

Classification of Types of Industries Replying

No.		Frequency	No.		Frequency
1	Paints—varnishes—lacquers	12	7	Molded products	2
2	Metallurgical	6	8	Celluloid and paper	2
3	Analytical	5	9	Electrochemistry	1
4	Dyes and intermediates	4	10	Rubber	1
5	Coal-tar, petroleum, and asphalt	3	11	Pharmaceutical	1
6	Fats, oils, and waxes	3	12	Medicinals and cosmetics	1

The returns and information from this survey are satisfactory. The entire industry within the Newark district (the largest manufacturing

center within Essex County) was covered, not just a sampling. Of the sixty-one firms either visited or otherwise reached by questionnaire, forty or sixty-five and six-tenths per cent made reply. These results were higher than from any other survey undertaken in the development of other courses in the Essex County vocational schools.

Of the forty returns received, twenty-eight or seventy per cent were interested in the work being undertaken. This number figures forty-five and nine-tenths per cent of the total number of firms reached. It was not to be expected that all the firms would be interested. Many are too small to use much help, others are still in the "trial and error" field of small specialty production, still others are being managed by men who have grown up in the old schools and have not or will not adjust themselves to modern developments, then, too, others are jobbers, that is, they sell only the finished product.

From question 2 of the survey on the analysis of the returns concerns itself only with those firms which expressed an interest in the problem by answering "yes." The legal age in New Jersey at which compulsory education ends is sixteen. Twenty-seven of the firms will not hire junior help under the age of sixteen. This of course, is due, among other things, to the fact that a great many of the employers object to continuation school. The present practice is to admit to the vocational school boys who are over fourteen years old. The course is two years long and so the boys graduate at sixteen. Studying the age figures further, it is found that fourteen replies, or about fifty per cent of the interested employers, prefer a boy seventeen years old or older. This changes the situation somewhat. If the demands of these employers are to be met, and they must be met if the graduates of the vocational schools are to find employment, the entrance age of at least fifty per cent of the pupils must be raised. That is, for every fourteen-year-old boy who enters one who is fifteen years old must also be enrolled. Either some plan as has been suggested must be worked out, or else the length of the course must be increased to three years. This latter suggestion offers many complications and is hardly feasible. The schools are operated for the training of normal boys and girls in accordance with the interpretation of the Federal Board for Vocational Education. Many pupils enrol because of the economic condition existing in their homes which requires that they learn some vocation in the shortest possible time. They do not want to, nor can they afford to, spend three or possibly four more years in school. In many cases even two years is too long. Further, if the course is lengthened to three years there is serious danger of getting away from the secondary nature of vocational training such as is being given in the Essex County Vocational School, and encroaching on the technical school and college field of professional training without the advantage of a more advanced degree of academic attainment,

bringing with it the opportunity for stronger foundations in the essentials necessary for professional study.

As the second part of question 2, "What minimum education in addition to his special laboratory training would you require?" is studied the situation just mentioned clears itself somewhat. Nineteen firms prefer boys who have had one or more years of high-school training. Further analysis of the replies to this question indicate that nine, or thirty-two and one-tenth per cent of the twenty-eight firms, who answered were hiring junior helpers who were grammar school graduates or under. Of this number twenty-eight and five-tenths per cent wanted at least grammar school graduates. It must be kept in mind that academically a grammar school graduate is a potential high-school student. Six firms, or twenty-one and four-tenths per cent, preferred boys who had one year of high school, seven firms, or twenty-five per cent, required two years of high school, one firm, or three and five-tenths per cent, asked for three years of high school, and five firms, or only seventeen and eight-tenths per cent, insisted on high-school graduates.

Amplifying the analysis of the returns to this question further, we find that those firms hiring boys who are grammar-school graduates or under use thirty-four and one-tenth per cent of the juniors employed in the industry in Essex County, firms asking for one year of high school employ seven and three-tenths per cent of the juniors, those asking for two years of high school use twenty-five and six-tenths per cent of the juniors, firms asking for three years of high school use seven and three-tenths per cent of the juniors, and, finally, those firms asking for high-school graduates use twenty-five and six-tenths per cent of the juniors. Summarizing these figures for purposes of final comparison we find that seventy-eight and five-tenths per cent of the chemical firms who responded to the survey hire sixty-seven per cent of the junior workers who have had only two years of high-school training or less, while twenty-one and three-tenths per cent use thirty-two and nine-tenths per cent of the workers and require three years of high school or better. Casual inquiry has developed that these industrial requirements for junior workers have not been set up on any scientific basis but because even in such a highly technical and scientific industry as chemistry the employers still feel that the geometry and algebra taught in high school give the pupil greater powers of analysis and concentration, that the Latin and Greek taught aid in the development of memory, *ad infinitum*. Of course the real explanation is probably that the added two years of academic training has resulted in additional pupil selection with the result that a boy of greater abstract intelligence is available. There is no scientific proof that such a boy will make the best chemical laboratory apprentice. His abstract intelligence may be misplaced. No thought is given to the fact that in this weeding-out process the economic

situation has logically removed many boys who would make junior laboratory technicians of just as much if not even more value than the economically fortunate high-school graduate. There is here a distinct problem of educating industry to a vocationally trained worker.

Under question 3 covering personal qualifications, the usual variety of characteristics were reported as desirable. There is no outstanding information revealed by this part of the survey. Each employer has his own ideas, and since, after all, it is not customary to measure or evaluate characteristics at the time of employment, the question has little value in determining employment possibilities at the time of enrolment in the vocational school.

Eighteen, or sixty-four and three-tenths per cent of the chemical firms in the Newark area, feel that the supply of junior workers is inadequate. These organizations employ fifty-two, or sixty-three and four-tenths per cent, of the eighty-two boys reported as being employed by the twenty-eight interested employers. This is a good percentage. Allowing for a normal turn-over of fifty per cent, there should be twenty-six openings for new boys yearly. At the present time the industrial chemistry class in the Essex County Vocational School has an enrolment of twenty to twenty-four pupils and a graduating group of four or five each year. This represents only about twenty per cent of the possibility. The course is still new and unknown. On the basis of these figures, there is justification in permitting the enrolment to grow to double its present strength. Even then, under normal conditions, training would be provided for only fifty per cent of the theoretical employment possibilities. This appears to be a safe working margin.

Of the firms reporting, thirteen, or seventy-two and seven-tenths per cent, report a starting wage of between $13.00 and $20.00 per week for junior workers. The rest have a somewhat higher initial rate, although a $35.00 per week beginning wage is open to question. The information regarding junior, senior, and women chemists was asked in order, if possible, to arrive at an index figure which would show the relationship between those classifications and the junior employment. The returns from this portion of the questionnaire indicate the employment of two juniors for each three college-graduate chemists.

The replies to "Possible Duties of Laboratory Boys" is interesting. The necessary information is given to plan the course on at least a partially scientific basis.

This survey has confirmed the thought that there is need for the training of junior laboratory technicians. From the analysis of the returns, entrance and age requirements as well as the control of the size of classes (to provide reasonable opportunities for placement after graduation) can be intelligently adjusted. Guesswork has been eliminated and a

course which will function with the greatest possible efficiency can be offered.

In conclusion it may be well to raise the point of comparison between a high-school boy and a vocational-school boy as viewed from the standpoint of the vocational school. For the sake of clarity and uniformity in thinking, we will define vocational education as that training whose controlling end and aim and standard of valuation is the fitting for useful employment. Furthermore, the type of school we are concerned with is not a disciplinary institution as so many people erroneously conceive it, but a type of school organized under the National Vocational Education Act probably better known as the Smith-Hughes Act of 1917. This act enacted by the Federal Government provides Federal subsidy for the development of vocational education in the various states and specifically states that "It may be well to note that the sort of education fostered under the Federal Act is not intended for backward, deficient, incorrigible, or otherwise subnormal individuals. Such education is intended for, and should command the best efforts of, normal boys and girls." The basic difference then between the high-school boy and the vocational boy lies in the course of study to which each is exposed. The high-school boy, for the most part, is still studying those subjects which are expected to qualify him for college. Little if any thought is given to their immediate use in the field of non-collegiate vocations. The vocational school boy, on the other hand, occupies his entire time in preparation for an immediate job in his chosen vocation upon completion of the course. As far as the study of chemistry is concerned the average high-school boy gets his share of that science only during the third or fourth year. And yet only thirty-two and nine-tenths per cent of the boys reported employed by Essex County chemists have completed three or four years of high school. Only one-third of the junior laboratory workers have been exposed to high-school chemistry. How far does this one year of chemistry train the worker? In the writer's estimation there is so little real chemical training that the boy might be better off without any. His smattering can only hope to make him self-conscious of an egoistic knowledge of badly muddled theory. What does he know of plant or laboratory procedures? Can he perform a quantitative filtration, can he ignite a precipitate, can he use the analytical balance? How can he be expected to, when, for the most part, his training has been limited to approximately forty weeks of possibly one and one-half hours of laboratory weekly, making hydrogen in test tubes, nitrous oxide in bottles, titrating a base with an acid when the standard (or near standard) acid is provided, etc. These illustrations have been taken at random from a standard laboratory manual. This boy's prospective employer does not care if he can do those things, but he does want the boy to handle equipment found in industrial practice with a maximum efficiency and a mini-

mum loss of time. I frankly believe that aside from arousing in the potential worker a desire to follow chemistry, there is no particular immediate value to the employer.

Contrast this condition with the training the Essex County Vocational School provides for its chemistry pupils. In the first place those boys who enrol for the course do so of their own volition. They are not fulfilling a scholastic requirement. They enrol for a two-year course consisting of forty-eight weeks each year and twenty-two and one-half hours of laboratory work per week. During this time the student does not learn how to make hydrogen or nitrous oxide but he does learn how to make simple precipitations which he filters through a Gooch or paper. He does learn the choice of paper for various types of precipitates. He does learn how to wash a precipitate, ignite it, and weigh it on the analytical balance. In other words he does not spend his time with theory supplemented with a small amount of illustrative laboratory work but with practical laboratory work supplemented only by such theory as may seem necessary.

These comments do not imply that the writer has no sympathy with high-school chemistry. He has when it is in its place but in this article that place cannot be construed as providing trained routine laboratory workers. These boys may develop into such workers but their practical training is in the hands of busy laboratory men. That training is excellent but it takes up the valuable time of a busy senior, and in industry time is a serious consideration.

Since a number of employers prefer high-school graduates even though we may admit that they are not specifically trained for their jobs, what have these boys to offer in the way of other qualifications that make them desirable? Of course in the mind of many laymen the theory of formal discipline still persists, that theory which implies the development of certain mental faculties through the study of certain subject-matter. In educational circles this theory has long been discarded. The only explanation which appears to offer itself is that of survival of the fittest. The boys who finish high school represent those who have the mental ability and whose families can afford to keep them in school. However these boys by no means represent all of those with the maximum mental ability which might successfully be turned to the mastery of chemistry. Because of economic conditions a great many boys must leave school at the age of sixteen. These boys, being normal, complete grammar school at fourteen or even somewhat younger. They still have two years of schooling to comply with the usual compulsory education laws and those two years spent in high school simply leave the boy hanging without any real preparation for life. Those are the boys we get in the Essex County Vocational Schools, normal boys who must leave school without completing high school. In a preliminary study to determine if the vocational boys

were normal, six hundred and fifty boys were required to take the Terman Group Test of Mental Ability. The mean intelligence quotient for the group was 91.5. Surely that figure represents a normal group. Binet gives 90–109 as normal. The boys tested did not represent any sampling of the school, but the entire student body. The chemistry group at that time consisted of twenty students who scored a mean I.Q. of 100. Certainly that group represents the equal of any average high-school group. Fourteen boys who have graduated (and all of them have been employed by the chemical industries) show a mean I.Q. of 102.1. These boys all have the mental ability of the average high-school boy, but the economic disadvantage which prevents their being sent to high school. We in Essex County are trying to enable these boys to capitalize their ability and prepare for a satisfactory place in our social and industrial civilization. We are offering high-type boys trained in the rudiments of chemical laboratory procedure to the chemical industry in place of the untrained and untried high-school boy some chemists seem to prefer. In this connection it may be interesting to note that three of the firms who said they preferred high-school graduates employed our graduates and were satisfied with their experiment. All of our graduates are being placed and they all stay put. They wanted the training, were trained, and consequently their persistence on the job has cut down the junior laboratory turn-over. If we can secure recognition from the chemical profession for the two years training we give as equivalent to two years beyond the grammar school we shall do the boys a great deal of good and I know we shall provide suitable recruits for the junior positions in our profession.

Flexible Wood. Real wood which can be cut with scissors and bent almost double without breaking is offered in a new product which combines the texture and attractiveness of natural wood with the workability of heavy cloth. It is made by cutting a thin veneer, $^1/_{60}$th to $^1/_{120}$th inch in thickness, which is glued to a paper or cloth backing; after being dried it is flexed by a mechanical process. It may be applied to walls by paperhangers and finished with sandpaper, shellac, and wax. Although the decorative features and economy of thin veneers have been known and used for many years, it is only recently that they have been made available on a large scale.

The new product can be applied to plaster, metal, wall board, or cheap grades of wood, which makes it adaptable to a wide variety of uses. One of the most popular is as a wall covering in place of ordinary wood paneling, for which there is a growing vogue. The appearance is said to be duplicated at one-half to one-third the cost, providing a finish which should be readily acceptable in high-class homes, hotels, clubs, libraries, stores, and executive offices. Since the appearance of wood finishes is generally preferred to that of metal, this new flexible wood may soon be used to cover metal in furniture, office equipment, Pullman car interiors, and elevator cabs, and, although the cost is higher, it may supplant to a large extent the unconvincing use of painted imitations of wood grain.—*Ind. Bull., Arthur D. Little, Inc.*

DETECTION OF FLUORIDES USING THE ZIRCONIUM LAKE OF ALIZARIN

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The color reaction between fluorides and the red zirconium lake of alizarin is utilized as a test for fluorine. This is a specific and sensitive test easily applied. The preparation and use of a stable reagent and test papers are described. These test papers, although less sensitive than the reagent solution, form a convenient and simple method for performing the test. A note on the interference of fluorides in the colorimetric determination of aluminum using Alizarin S is included.

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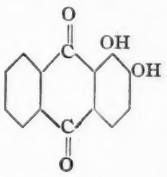
During an investigation of some metallic derivatives of alizarin sulfonic acid De Boer (*1*) found a characteristic reaction for zirconium (the insolubility of its alizarinate in concentrated hydrochloric acid). This test, however, could not be performed in the presence of fluorides, even mere traces interfering. He therefore suggested this reaction as a possible test for the fluoride ion.

It was found that the use of alizarin (1:2 dihydroxy-anthraquinone), Color Index number 1027 (*2*), instead of alizarin sulfonic acid, gave a more



sensitive reagent which was less likely to react with interfering substances. This paper reports a simple method for preparing the test reagent, the interferences, sensitivity, and the preparation and use of convenient test papers.

To prepare the reagent, dissolve 0.5 g. of alizarin in 200 cc. of alcohol with the aid of heat. Dissolve 1.5 g. of zirconium chloride in about 75 cc. of alcohol. Mix the two solutions and allow the precipitated lake to settle. Filter or centrifuge and wash twice with alcohol. The moist precipitate is then suspended in sufficient alcohol to make the volume 25 cc. Five cc. of this suspension is added to 100 cc. of water and shaken thoroughly. This more or less colloidal suspension is the reagent for use in the test and should be shaken before use.

After some preliminary experiments the following procedure for performing the test was adopted: to 2.5 cc. of the neutral or slightly acid solution to be tested add an equal volume of concentrated hydrochloric acid. Then add 0.5 cc. of the reagent and mix. Allow to stand for not longer than fifteen seconds. If the test solution contains more than 0.3

mg. of fluorine the red color of the reagent will turn yellow practically immediately. Fifteen-hundredths mg. of fluorine takes about five seconds to decolorize the reagent, while 0.03 mg. requires fifteen seconds. This is the practical limit of the test. It is possible to make this reaction more sensitive by using less reagent and allowing to stand longer, but this is done at the expense of its specificity; ions such as sulfate, phosphate, and oxalate then decolorizing the reagent. In the known absence of interfering substances one may detect 0.0015 mg. of fluorine in 5 cc. by using 0.1 cc. of the reagent and allowing to stand five minutes.

Under the conditions of the test as given, the ions found to interfere were the strong oxidizing halogen salts, such as chlorates, bromates, and iodates, which liberate the free halogen on acidification. Any combination of salts which liberates free halogens will produce the same interference. The liberated halogen bleaches the color of the reagent. In order to obviate this interference add a small excess of a freshly prepared saturated solution of sodium sulfite to the test solution before acidification and proceed with the test as usual. Colored ions and compounds giving a precipitate on acidification interfere in a physical manner by masking the color change of the reagent. In the presence of interfering colored ions the method of isolating the fluoride ion will, of course, depend on the nature of the interfering substance. Various methods can easily be devised for each particular case, but in general it is usually more practical to have recourse to one of the well-known inorganic tests when the separation is at all lengthy. Oxalates, sulfates, and phosphates have a tendency to decolorize the reagent on long standing, but under the conditions given do not interfere. High concentrations of phosphates cause the colloidal reagent to form large flocs, but they are not decolorized in the time allowed. Complex ions containing fluorine as silicofluoride or borofluoride give a positive test.

A convenient though less sensitive method of performing the test is by means of test papers which may be prepared as follows: 2 g. of zirconium chloride is dissolved in 100 cc. of alcohol. Hardened filter paper, such as No. 50 Whatman's, is immersed in this solution and allowed to dry. The papers are next immersed in a solution of 0.1 g. of alizarin in 100 cc. of alcohol and hung up to dry. When dry, cut off and discard the edges of the paper and cut the remainder into strips 5 mm. wide. To perform the test, add an equal volume of concentrated hydrochloric acid to the neutral or slightly acid solution to be tested. Immerse a strip of the test paper for five to ten seconds. The reddish color of the paper will turn a pure yellow if fluorides are present. Orange tints of the paper do not indicate a positive test. The reaction is sensitive to about 0.3 mg. of fluorine per cc., the yellow color appearing in about ten seconds. Higher concentrations of fluoride ions effect a much more rapid color transition. The color of the test papers should be noted before the expiration of about twenty seconds.

If allowed to stand longer high concentrations of sulfate and phosphate are liable to give misleading tints. Free halogens in the test solution may be treated with sodium sulfite as given above.

In the determination of aluminum by the method of Atack, using Alizarin S Red (sodium salt of alizarin sulfonic acid), as described by Yoe (*3*) the interference of fluorides is not mentioned. It was found that as little as 0.3 mg. of fluorine in the final solution containing large amounts of aluminum produced complete decolorization of the aluminum lake, rendering any colorimetric comparison completely in error. The objection to the use of the aluminum lake as a test reagent for fluorides is its solubility in mineral acids.

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(*2*) "British Color Index of the Society of Dyers and Colorists," Leeds, England, **1924**, p. 248.
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Woodworking Plants: New Source of Dust Explosions. Wood not only burns; it also explodes. The facts that wood dust is one of the most serious sources of dust explosions and is more easily ignited than some of the grain dusts which have been the cause of many fatal disasters, are a part of the latest information learned from investigations by dust explosion engineers.

Linoleum, bakelite, dynamite, tooth-paste tube tops, and ash trays are largely responsible for the recent increase in the hazard of wood dust explosions. These articles frequently have in their composition quantities of wood flour, which is much finer than sawdust—so fine that it will pass through a 200-mesh screen.

"The finer wood dust is made the greater the danger of explosion from it," says Hylton R. Brown, of the U. S. Department of Agriculture, who has made extensive studies of dust explosions.

"The first dust explosions occurred in flour mills and for many years such explosions were the only ones reported. Now the hazard is recognized in grain elevators, starch factories, sugar refineries, woodworking plants, textile mills, and factories in which rubber dust, sulfur dust, metallic dusts, powdered milk chocolate and cocoa, or other combustible materials in the form of dust are manufactured or handled.

"In the laboratory, tests have shown that wood dust is more easily ignited and produces higher pressures than some of the grain dusts which experience has taught are capable of producing tremendous pressures and completely destroying concrete and steel structures when the proper mixture of dust and air is ignited."

Mr. Brown has measured the force of test explosions caused by the dust of different woods and he finds it difficult to say which wood causes the greatest explosion. From a concentration of two ounces of dust per cubic foot, an explosive force as great as twenty-six pounds per square inch has been obtained.

"If any comparison can be drawn," he said, "it is that softwoods as a rule produce higher pressures than hardwoods when the concentration is low, but as the concentration increases the pressures increase more rapidly for hardwood than for softwood."

Cleanliness, elimination of sources of ignition, and prevention of static electricity were suggested as safety measures.—*Science Service*

A METHOD OF DISPENSING QUALITATIVE UNKNOWNS*

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A simple yet flexible system has been devised for easily and uniformly preparing and issuing unknowns to a large class. Each student is forced to make a definite and final decision based upon his own work. Dishonesty on the part of the student and bias on the part of the assistant cannot become involved in this system.

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A successful qualitative analysis course demands that careful consideration be given to the preparation and dispensing of the unknowns. The introduction of qualitative analysis in the spring semester of the first year of college chemistry has changed the general attitude of both the class and the instructor. In a second-year course the students are usually only those who are interested in science and are really attempting to become acquainted with this form of analysis. It makes very little difference to them if their unknowns are knowns. In the first-year courses those attempting the analysis are too frequently there because it is a part of the required curriculum or the lesser of "academic evils." Any method to get through, any dodge or excuse is too frequently their goal. Being a beginning course the class is placed in the hands of the younger and less experienced instructors. They are usually too busy with their own work to consider the general welfare of the course and too often they too are looking for the easiest escape. A number of methods of handling unknowns has been tried and from experience with them the following method has been derived.

To illustrate this routine method, which we have found convenient to use, let us select the silver group and explain the handling of it in detail. The same methods, of course, will apply to the preparation of any type of unknown in any group or in unknowns involving any number of groups.

It is possible to prepare seven different combinations of unknowns with the three elements in this the silver group. On a piece of scratch paper is prepared a list of these combinations, or of those desired to be used, together with the number of unknowns to be made of each. Thus one may prepare the same number of samples of each combination or vary the number as desired. This group being the first studied by the class, they would thus all bear the letter *A* on the label of each unknown. To supply a class of sixty, a complete set of bottles for these unknowns are labeled from *A*-1 through *A*-130; thus providing two unknowns for each student. The extra ten form a convenient margin for accidents, repetitions, etc.

The bottles to be filled with one type of unknown, let us say the silver and lead ions, are selected at random. These are arranged in a row and in each is placed the proper amount of silver solution, then the lead solution.

* Presented before the Division of Chemical Education at the 80th meeting of the American Chemical Society, Cincinnati, Ohio, Sept. 8–12, 1930.

They are now diluted, corked, and recorded. The combination of silver and lead on the preparation list is then crossed off, and a new combination is selected for the next set of unknowns. This is followed by a third set and so on until all seven sets are prepared, or as many of them as are desired.

We have found it convenient, in keeping records, to use two booklets such as most schools use for their examinations. More permanent books may be used if desired. Similar lines on the like pages in each book are numbered. In one book, "the key book," is recorded the constituents present in the unknowns. The other book, "the report book," is spaced for the following records on each unknown: the unknown number, the name of the student to whom it is issued, the student's report with room for correction by the instructor, and a space for the grade. In our laboratory this latter book is kept at the supply window where the unknowns are obtained by the student. When a student desires an unknown, his name is placed beside the number of the unknown issued to him. His report, when made, is recorded opposite his name and number. This of course prevents more than one student reporting on the same unknown. At stated intervals, with us the middle of each laboratory period, the unknowns are graded by the professor in charge. A page of the "key book" is placed upon the similar page of the "report book" in such a manner that corresponding lines join and at the same time the names of the students are covered. This will bring the student's report and the correct analysis side by side. Thus it is possible for the instructor to quickly and unbiasedly grade. For the student's information each report is corrected. The student consults the "report book" for his grade. These grades may be transferred to a record book if desired.

Some of the obvious advantages of this system are:

1. *The uniformity of preparation and issue* of the unknowns is apparent. Like unknowns may be mixed in a beaker and each bottle filled from the common solution. The student known to be "weak" is too often given easy unknowns while a good student is given a difficult one. While it is an advantage for the instructor to encourage the "weak" and test the "strong" with proper types of unknowns, yet it is usually a student assistant, often a fraternity brother or friend, upon whom the task of issuing the unknowns falls. Since the assistant who made the unknowns and the professor with the "key book" are the only ones who know anything about the unknowns, the human element is removed.

2. *The ease of preparation of a large number* of unknowns minimizing the chance of errors becomes more evident as one becomes familiar with the system. One may incorrectly list opposite the number, forget to record a set of numbers, or make other mechanical errors, but most, if not all of these, will become apparent before the whole set is completed. Not

only are the errors noticed but those bottles involved are evident as well. We have found that this method has reduced the usual mechanical errors to almost *nil*.

In recording or marking the bottles of the unknown one does not have a long set of numbers to deal with, as in the system suggested by Taylor at the Atlanta meeting of the American Chemical Society, nor tags to lose or become hopelessly mixed (*1*). Using only three numerals together with a letter to represent the type of unknown, twenty-six sets of unknowns with 999 unknowns to the set can be prepared.

3. *No biased aid* can be obtained by the student either wilfully or otherwise from the instructor, for our "key book" is unavailable except at times of grading. The habit of shopping for the easy grading instructor or the instructor who will permit the "I think I got a test for" or "a sort of test for" reports is prohibited. Since all unknowns are graded by one individual and only at stated intervals, the student must make a definite decision from his own work. In the laboratory the instructors are at liberty to give their own opinions since they know nothing about any of the unknowns except what the student has showed them.

4. *The honesty of the student is not involved*, in that it is impossible for any one other than the individual to whom the unknown is issued to make the report. The unknown, once reported for a grade, cannot be reported by other individuals as is possible under many systems.

5. There is *no system to be handed down* from class to class nor the method of analyzing the unknown from its number as in Taylor's method.

6. The above method is *flexible* enough to meet local conditions and still be carried on successfully.

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Depths of Earth Yield Solid Carbon Dioxide. From the interior of the earth beneath Jackson county, Colorado, comes snow white, solid carbon dioxide, which freezes at 70 degrees below zero Fahrenheit. Enough is obtainable in one day to fill a train, Prof. F. F. Hintze, of the University of Utah, revealed in a report to the American Institute of Mining and Metallurgical Engineers.

Prof. Hintze explains with proper technical exactness that the carbon dioxide is contained in the earth as a gas under very high pressure, not as the cold solid. But when it comes to the surface, mixed with about 10 per cent oil, it expands so fast upon being released from confinement and gives up so much heat that it freezes both itself and the oil.

In its frozen state engineers would apply this gas, the same that is exhaled from human lungs, to the refrigeration and preservation of food.—*Science Service*

MOLECULAR-WEIGHT APPARATUS FOR THE BOILING-POINT METHOD

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A new apparatus for the determination of molecular weights by the boiling-point method is described. Two Beckman thermometers, one measuring the boiling point of the solution, the other measuring that of the solvent, are read simultaneously when equilibrium is reached, obtaining thus the boiling-point rise directly. Simplicity and ruggedness of construction with ease of operation and accuracy of determinations are the features of the apparatus.

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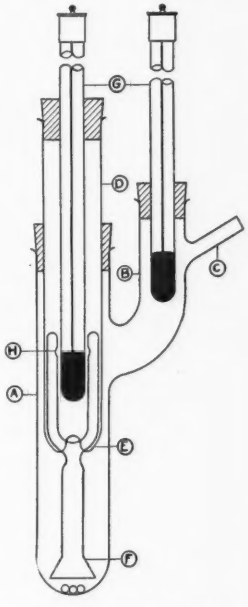
Of the many types of apparatus for the determination of molecular weights by the boiling-point method, few are found to combine simplicity with ease of operation commensurate with results of high accuracy. With these points in view the following apparatus was devised, consisting essentially of a modified type of Cottrell pump (*1*) discharging over the bulb of a Beckman thermometer, measuring thus the boiling temperature of the solution, while a connecting side-arm equipped with another Beckman thermometer measures the boiling temperature of the pure solvent.



The assembled apparatus is sketched in the accompanying diagram. It is constructed of pyrex, and consists of a 32-mm. test tube *A* with a 20-mm. side-neck *B*, the latter having an arm *C* for a condenser; the inner tube *D* is a 24-mm. test tube with a socket *E* from which the modified Cottrell pump *F* is suspended, the latter consisting of a "U" of 4-mm. tubing closed at the upper end and having a 3-mm. orifice *H* 10 mm. from the top. The vertical tube *F* is 6 mm. when water is used as the solvent, while for low-boiling solvents 4-mm. tubing is more suitable. The Beckman thermometers are held in place by foiled corks, and should be provided with some form of a mechanical tapper to prevent sticking of the mercury threads. Glass beads are used to prevent bumping.

By the mechanical pumping of the solution in a thin layer over the thermometer bulb, the errors arising from superheating are reduced to relative insignificance. In the determination of the boiling point of the pure solvent there is some danger of superheating occurring, but this

can be reduced to a minimum by surrounding the bulb of the Beckman with a small cylinder of platinum gauze and maintaining an even ebullition rate throughout the determination. To this end, the apparatus should be well shielded from drafts: an asbestos shield with a mica window, for observing the pumping action, will be found suitable.

The simplicity of operation is apparent. The apparatus is cleaned and dried, assembled and charged with 25 to 35 cc. of the solution and, by means of gentle heating, brought to boiling so that the liquid is being pumped and discharged over the bulb of the thermometer, and at the same time in the connecting side-arm the pure solvent vapor should be just condensing within the condenser. The Beckman thermometers, which have been compared with each other by noting the difference of their readings when both are at the same temperature, are then read when equilibrium is reached and the net temperature rise thus determined.

Although designed for use with aqueous solutions, other solvents may be used, provided the diameter of the tube *F* is commensurate with the physical properties of the solvent in order that maximum pumping action at a gentle ebullition rate be obtained.

With a minimum of care and operation this simple apparatus will give quite accurate results.

The author desires to express his appreciation to Professor B. P. Caldwell of the Polytechnic Institute of Brooklyn, Brooklyn, New York, for many suggestions dealing with this apparatus.

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Cottonseed Meal Good Pellagra Preventive. Cottonseed meal has been hailed as the cheapest source of the pellagra-preventive vitamin yet found, according to a statement by Dr. W. W. Skinner of the U. S. Bureau of Chemistry and Soils. Besides being rich in the anti-pellagra vitamin G, cottonseed meal was found to be an important carrier of the anti-beriberi vitamin B.

Yeast is considered the richest source of both these vitamins, but yeast is costly. Now it may be possible to use the less expensive cottonseed meal in treating pellagra. This would be of great benefit to pellagra sufferers who have generally acquired the disease from improper diet due to poverty.

Pellagra is known as the hard-times disease throughout the South where it is prevalent. Yeast, fresh milk, fish, lean meat and eggs, which all contain the pellagra-preventive vitamin, are costly and absent from the diet of the poorer classes, particularly during hard times.

Cottonseed meal is commonly used as a cattle feed. It is now considered to rank next to yeast in content of vitamins B and G.

Mr. Stevens directed the studies which were carried on jointly by the Department of Agriculture and the National Cottonseed Products Association.—*Science Service*

A NEW TYPE OF ELECTRICALLY HEATED MUFFLE FURNACE*

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A top-opening electric muffle furnace has been built holding 22 size 0 crucibles, any one of which may be removed without disturbing the others. Its chief characteristics are large hearth area and easy access to crucibles. A time-temperature curve, compared with a furnace of conventional design but of 33 per cent less capacity, shows a higher rate of heating up to 600° C., but a lower rate thereafter. The two curves cross at 850° C. The power consumption per crucible for the two furnaces is practically the same.

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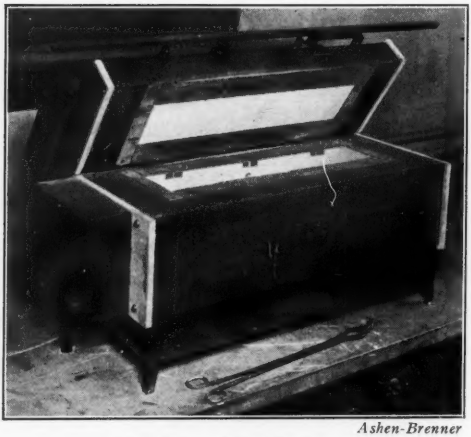
The stock type of end-opening muffle furnace universally used is poorly adapted to use in college laboratories where several students are required to use the same muffle simultaneously. The first crucibles inserted are certain to be the first removed and it is difficult to accomplish this without danger of overturning the crucibles near the front. An attempt has been made to design a top-opening muffle of considerable hearth area in which this source of trouble is obviated. Following our design, the Hevi Duty Electric Company, Milwaukee, Wisconsin, has built such a furnace, now in use in the chemical laboratory of Washington University. The two photographs, Figures 1 and 2, show views of the furnace closed and opened.

Ashen-Brenner

FIGURE 1.—CLOSED FURNACE

The furnace shell is a sheet iron box 74 cm. long, 18.5 cm. deep, and 34.5 cm. wide, with ends of heavy transite board. The muffle is made of refractory, grooved muffle plate and is in the form of a rectangular box 51 cm. long, 7.6 cm. deep, and 11 cm. wide. The hearth area is 561 cm.^{2} and is sufficient to carry twenty-two size 0 crucibles, which are each 41 mm. in diameter. Any crucible may be removed without disturbing the others. The capacity of the muffle is 3758 cm.^{3} Electrical heating units are installed in grooves of the muffle plates which form the walls and the

* Presented before the Division of Chemical Education at the 80th meeting of the American Chemical Society, Cincinnati, Ohio, Sept. 8–12, 1930.



Ashen-Brenner

FIGURE 2.—OPEN FURNACE

hearth. These units are of an 80% nickel, 20% chromium alloy. They terminate in a ventilated sheet iron box shown at the left end. The furnace is insulated with two courses of C 22 brick in the hotter zone next to the heating units, and with Johns-Manville Superex slabs next to the shell. The top of the muffle box is faced with strips of Enduro KA2 steel, 6 cm. wide, placed with their edges flush with the inside of the muffle plates. At intervals a portion of the steel facing plate is bent downward about 1 cm. to aid in supporting the side walls of the muffle. (See Figure 2.) At 5-cm. intervals, a 2.5-cm. slot has been sawed into the plates to reduce the tendency to buckle when hot. A $^1/_2$-inch hole in the back wall of the muffle permits the insertion of a pyrometer point at the geometrical center of the heating chamber.

The lid of the furnace is an inverted box of sheet iron 74 cm. long, 23 cm. wide, and 6.8 cm. deep, hinged at the back on the projecting face of the furnace shell. The lower side of the lid consists of a grooved refractory plate carrying heating units. This is held in place by a facing plate of Enduro KA2 steel. (See Figure 2.) The total weight of the lid is counterpoised by two adjustable iron weights. (See Figure 1.) A long bar of $^1/_2$-inch square iron, supported on brackets, serves as a handle for raising the lid.

The furnace operates on 110 volts, A. C., through a line resistance rheostat and carries from 24 to 25 amperes at full load. It is designed to operate safely at 980°C. and its maximum temperature is 1040°C.

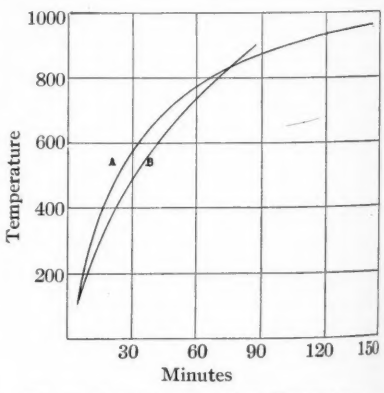


FIGURE 3.—HEATING RATE CURVES OF MUFFLE FURNACES

A, top-opening; *B*, end-opening.

Curve *A*, Figure 3, shows the heating characteristics of the furnace up to 960°C., when operating at full load. Curve *B* is the heating curve of a popular make of end-opening muffle of the conventional type, but having a much smaller cubical capacity and hearth area. It will be noted that the rate of heating for the new furnace is higher than that of the old up to about 600°C., but is slower thereafter. Both furnaces reached 850°C. in 77 minutes.

Table I shows some comparative data on the two types of furnace. It will be noted that the power consumption, per crucible, is practically the same for the two furnaces.

TABLE I

Comparison of Top- and End-Opening Muffle Furnaces

	Top Opening	*End Opening*
Cubical capacity	3759 cm.³	3122 cm.³
Hearth area	561 cm.²	318 cm.²
Ratio of hearth area to cubical capacity	0.149	0.101
Crucible capacity, size 0	22	15
Amperes at 110 volts	25	16.4
Amperes per crucible	1.14	1.09
Time (minutes) to reach 900°C.	98	86

Because of the large area exposed when the furnace lid is opened for the removal of crucibles, it was feared that there would be a serious loss of temperature due to radiation. On opening the lid for the removal of two crucibles, the pyrometer temperature dropped from 960°C. to 790°C. but was back to 960°C. again in about four minutes. The end-opening muffle lost only 15°C. in the same operation. The pyrometer temperature loss is, of course, greater than the loss on the crucibles.

Potassium Found to Give Off Rays Like X-Rays. The common chemical element potassium gives off gamma rays similar to X-rays or the gamma rays of radium. At the State Radiological Institute in Prague, Dr. F. Behounek has confirmed the researches of Dr. W. Kohlhörster which gave evidence of these rays from potassium about two years ago.

Dr. Behounek finds that potassium chloride really emits gamma rays, the intensity of the rays being proportional to the amount of potassium. He also finds that there are two groups of gamma rays, one about as penetrating as the similar rays from radium, the other about twice as penetrating. However, their intensity is very low, so that very delicate apparatus is needed to detect them. It has been supposed that potassium resembles radium in that it is constantly decaying, with the liberation of gamma and other rays, and that in 1,000,000,000,000 years half of a given amount of potassium would have disappeared into radiation. Radium will lose about half of its original mass in 1750 years. But Dr. Behounek finds that the intensity of the gamma rays from potassium is much less than would correspond to the generally accepted period of decay.—*Science Service*

POSITIONS OPEN IN VARIOUS COLLEGES AND UNIVERSITIES TO GRADUATE STUDENTS MAJORING IN CHEMISTRY

For several years the JOURNAL OF CHEMICAL EDUCATION has published* a list of various Fellowships, Scholarships, and Part-Time Assistantships open for the ensuing academic year to graduate students majoring in chemistry in different colleges and universities. This present list, compiled in the editorial office of THIS JOURNAL, continues that custom.

The Fellowships, Scholarships, and Assistantships listed below are for the academic year 1930-31. It is possible here to give only a very brief statement concerning these positions. Further details as well as application blanks may be obtained from the persons designated. In general, it may be stated that candidates for these positions must file their applications not later than February 15, 1931. The colleges and universities are alphabetically arranged.

The editorial office would appreciate being advised of any errors or omissions in this present compilation.

Agricultural and Mechanical College of Texas, College Station, Tex.—4 Graduate Fellowships ($600 and exemption from tuition but not laboratory fees) in cottonseed oil mill operations. Work leads to M.S. degree in Ch.E. Address inquiries to C. C. HEDGES, *Vice-Dean*, School of Engineering.

Baylor University, Waco, Tex.—5 Part-Time Assistantships ($120 without remission of tuition of $180); eight hours' service required weekly in laboratory assisting and notebook grading. Address inquiries to W. T. GOOCH.

Boston College, Chestnut Hill, Mass.—4 Fellowships ($600 with exemption from tuition, laboratory, and breakage fees) restricted to candidates for M.S. degree. Nine hours' laboratory supervision required. Address inquiries to REV. JOSEPH J. SULLIVAN, S. J.

Brown University, Providence, R. I.—10 University Fellowships ($550-1000); 10 scholarships (stipend covering tuition). Holders of Fellowships who report for duty on August 1st are not required to pay tuition. 8 Graduate Assistantships ($750 and exemption from tuition), approximately 4 are vacant each year. Address inquiries to CHARLES A. KRAUS.

Bryn Mawr College, Bryn Mawr, Penna.—Helen Schaeffer Huff Memorial Research Fellowship (physics or chemistry) ($1200); 1 Fellowship ($860); 1 Graduate Scholarship ($400). No exemption from tuition ($250). Occasional proctoring and library supervision required of Fellows; Fellows not allowed to teach. Address inquiries to DEAN EUNICE MORGAN SCHENCK or J. L. CRENSHAW.

Bucknell University, Lewisburg, Penna.—1 Fellowship (chemical engineering) ($500 plus tuition of $300); approximately 12 hours of laboratory supervision and correction of reports. 1 Scholarship (chemical engineering) ($300); approximately 6 hours of laboratory supervision and correction of reports. Address inquiries to S. C. OGBURN, JR.

California Institute of Technology, Pasadena, Calif.—4 Graduate Assistantships ($750); 6 Teaching Fellowships ($900); 1 du Pont Fellowship ($750); 3 Applied Chemistry Assistantships ($750). The tuition ($180) must be paid until the holder has been accepted as a candidate for the Ph.D. degree, then half tuition ($90) must be paid. Address inquiries to R. C. TOLMAN.

* THIS JOURNAL, **4**, 96–8 (Jan., 1927); **5**, 338–42 (Mar., 1928); **6**, 109–14 (Jan., 1929); **7**, 389–97 (Feb., 1930).

Carnegie Institute of Technology, Pittsburgh, Penna.—Several Coöperative Fellowships with the Pittsburgh Station of the United States Bureau of Mines ($750). Address inquiries to JOHN D. BEATTY.

Case School of Applied Science, Cleveland, Ohio.—1 du Pont Fellowship ($750); 1 du Pont Scholarship ($500); 4 Drury Fellowships ($750); 3 Teaching Fellowships ($300 plus tuition and fees amounting to $350). Six hours per week of laboratory supervision required of teaching Fellows. Address inquiries to PRESIDENT W. E. WICKENDEN.

The Catholic University of America, Washington, D. C.—Several Knights of Columbus Scholarships (including board, lodging, and tuition). Address inquiries to RICHARD J. PURCELL, *General Secretary.*

Clark University, Worcester, Mass.—Several Scholarships for first-year graduate students ($200); 4 Part-Time Assistantships ($100–150). No exemption from tuition ($200). Assistant may also hold Scholarship. Address inquiries to C. E. MELVILLE, *Registrar.*

Clemson Agricultural College, Clemson College, S. C.—1 Fellowship ($500). This is a part-time Fellowship and the holder would be able to obtain his master's degree in two years. Address inquiries to R. N. BRACKETT.

Colorado College, Colorado Springs, Colo.—Half-Time Instructorship ($700 and exemption from tuition and laboratory fees but not from breakage fees). In charge of laboratory and demonstration apparatus in general chemistry. Address inquiries to FRANK W. DOUGLAS.

Columbia University, New York City.—Various Fellowships ($750–1800) and Scholarships ($300). These Fellowships and Scholarships do not involve any teaching duties. Address inquiries to SECRETARY OF COLUMBIA UNIVERSITY.

There are also a number of Assistantships ($500–1000). Address inquiries to H. C. SHERMAN.

Connecticut Agricultural College, Storrs, Conn.—1 Part-Time Assistantship ($800 and exemption from tuition). Nine hours' laboratory supervision in elementary course. Address inquiries to HOWARD D. NEWTON.

Cornell University, Ithaca, N. Y.—2 University Fellowships ($400–750 and exemption from tuition and laboratory fees); 50 Assistantships ($500–675 and exemption from fees); 1 University Scholarship ($200 and exemption from fees). Address inquiries to L. M. DENNIS.

Duke University, Durham, N. C.—3 University Fellowships ($600–800); 3 Industrial Fellowships ($750); 6 Assistantships ($300–600). Address inquiries to PAUL GROSS.

The George Washington University, Washington, D. C.—4 Thomas Bradford Sanders Fellowships ($600 with exemption from tuition). Address inquiries to the REGISTRAR.

Harvard University, Cambridge, Mass.—Several Scholarships ($400–750). Address inquiries to L. S. MAYO, *Assistant Dean* of the Graduate School of Arts and Science.

A number of half-time Laboratory Assistantships ($850). Holders of such positions must pay a tuition fee of $200 besides fees for breakage and certain materials. A number of scholarships ranging from $400 (tuition) to $750. No duties. Full-time study required. Address inquiries to GREGORY P. BAXTER.

Holy Cross College, Worcester, Mass.—6 Fellowships ($1000 and exemption from tuition). Maximum of nine hours per week required instructing in either general or inorganic chemistry. Address inquiries to REV. GEORGE F. STROHAVER, S. J.

Indiana University, Bloomington, Ind.—Special Fellowships ($1000–1200), minimum requirement, Ph.D. degree or equivalent; 1 Fellowship ($600); several part-time

Assistantships ($400–800); 2 Grasselli Chemical Company Fellowships ($350); 1 Wolff Coal Saver Co. Fellowship ($500). Address inquiries to R. E. LYONS.

Iowa State College, Ames, Iowa.—2 Scholarships ($270); 3 Teaching Fellowships ($540); 12 Graduate Assistantships ($700); 4 Research Fellowships ($600 or $700). Address inquiries to W. F. COOVER.

The Johns Hopkins University, Baltimore, Md.—The William H. Grafflin Scholarship ($1000 with exemption from tuition unless student is a candidate for a degree) for independent research in industrial chemistry. Appointment made for two years. The Harry Clary Jones Fellowship in physical chemistry ($1000 with no exemption from tuition or other fees). 1 du Pont Fellowship ($750). Address inquiries to E. EMMET REID.

10 to 12 Assistantships ($700 without remission of tuition or fees). Ten hours work required in undergraduate instruction. Address inquiries to G. H. CARTLEDGE.

8 or 10 University Scholarships ($200–250). Address inquiries to the REGISTRAR.

10 State Fellowships ($1000, with no exemption from tuition or fees), open to second-, third-, and fourth-year students. The states in which these Fellowships will be available for 1931–32 are: California, Connecticut, Georgia, Illinois, Iowa, North Dakota, Oregon, Utah, Arizona, Nevada, New Mexico (one available among three states); Idaho, South Dakota, Wyoming (one available among three states). Address inquiries to NEIL E. GORDON.

Kansas State Agricultural College, Manhattan, Kans.—Several Graduate Assistantships (at approximately $600). Address inquiries to H. H. KING.

Lafayette College, Easton, Penna.—2 Research Fellowships ($500 and $750); 1 Research Associate ($2500–3500) for investigation of problems connected with plasticity, elasticity, and fluidity. Address inquiries to EUGENE C. BINGHAM.

Lehigh University, Bethlehem, Penna.—Fellowships giving half-time to research and half-time to graduate study, with exemption from laboratory and other university fees: New Jersey Zinc Co. Research Fellowship ($600); Archer-Daniels-Midland Co. and William O. Goodrich Co.: 4 Fellowships ($900) for research in linseed oil and other drying oils; H. M. Byllesby Memorial Research Fellowship ($750); Barrett & Co. Leather Research Fellowship ($900); Hunt & Rankin Leather Co. Research Fellowship ($900); Lehigh Institute of Research Fellowship ($600); 2 Student Research Fellowships ($750) open only to Lehigh graduates. Foregoing all two-year appointments. Address inquiries to H. M. ULLMANN.

Louisiana State University, Baton Rouge, La.—2 Scholarships ($150), work in stockroom; 6 Fellowships ($450), 10 hours of laboratory supervision required; 3 Assistantships ($900), 16 hours of laboratory supervision required. Fellows and Assistants are exempt from tuition and certain university fees. Address inquiries to CHARLES E. COATES.

Massachusetts Agricultural College, Amherst, Mass.—1 Graduate Assistantship ($60 per month for ten months), one half-time, assisting in laboratory courses required; 1 Laboratory Assistantship ($1200). All fees remitted. Address inquiries to JOSEPH S. CHAMBERLAIN.

Massachusetts Institute of Technology, Cambridge, Mass.—12 Full-Time and Half-Time Assistantships in the various branches of chemistry. Allotments of funds to applicants furnishing evidence of superior scholarship. The dean's committee had approximately $6000 in scholarship funds available for 1929–30 to assist students in pursuing graduate work. In addition there are eleven Fellowships. Address inquiries to FREDERICK G. KEYES.

Michigan State College, East Lansing, Mich.—14 Half-Time Graduate Assistant-

ships ($800), 4 in physical, 3 in organic, 2 in metallurgy, 3 in biochemistry, and 1 in analytical. Address inquiries to ARTHUR J. CLARK.

Middlebury College, Middlebury, Vt.—1 Graduate Fellowship ($750 and exemption from tuition, laboratory, and breakage fees). Half-time required in laboratory supervision of general chemistry and qualitative analysis. Address inquiries to P. CONANT VOTER.

Mills College, Oakland, Calif.—2 Trustee Fellowships (expenses of residence and tuition). 1 Amelia Anne Pease Fellowship ($500) and 2 Graduate Scholarships (tuition) open for study in any department. Fellows are expected to devote some time to assisting in their respective departments. Address inquiries to CHAIRMAN OF THE COMMITTEE ON FELLOWSHIPS.

Missouri School of Mines and Metallurgy, Rolla, Mo.—4 Graduate Assistantships ($600 and exemption from laboratory fees). The graduate assistant is limited to two-thirds of a full-time schedule per semester toward a master's degree. Address inquiries to the DEPARTMENT OF CHEMISTRY.

4 Research Fellowships in Metallurgy and Mining ($800 for ten months beginning Sept. 1, 1931). Fellows pay fees amounting to approximately $44 per year. Address inquiries to DIRECTOR.

New York University, New York City, at *University Heights* (*Nichols Laboratory*).—Several Junior Teaching Fellowships ($600 with exemption from fees for three graduate courses); several Senior Teaching Fellowships ($800 with similar exemption). About six new appointments yearly. Address inquiries to ARTHUR E. HILL.

At Washington Square College.—Several Junior Teaching Fellowships ($800 with exemption from three full courses in the Graduate School); several Senior Teaching Fellowships ($1000 with exemption as above); about fifteen new appointments yearly. Address inquiries to W. C. MACTAVISH.

Northwestern University, Evanston, Ill.—20 Graduate Assistantships ($800–1200); 4 Research Fellowships at ($750–900); graduate tuition depends upon the number of semester hours of credit carried but does not exceed $150 per year in any case, research chemicals are supplied, charges made for breakage. Address inquiries to CHAIRMAN, DEPARTMENT OF CHEMISTRY.

Oberlin College, Oberlin, Ohio.—Several Oberlin College Fellowships ($500 and exemption from tuition and fees); 2 Graduate Assistantships ($750 with similar exemption); 2 Scholarships calling for exemption from tuition and fees. Address inquiries to HARRY N. HOLMES.

The Ohio State University, Columbus, Ohio.—13 Part-Time Assistantships ($1000); 34 Graduate Assistantships ($500); a variable number of University Fellowships ($500) and Scholarships ($300). Address inquiries to W. L. EVANS.

1 special Fellowship ($750). All of the above carry exemption from fees (except matriculation and diploma fees of $10 each) and cost of chemicals. Address inquiries to GRADUATE SCHOOL.

Oklahoma Agricultural and Mechanical College, Stillwater, Okla.—7 Graduate Assistantships ($500 first year and $600 the second year with exemption from tuition and chemical fees). Address inquiries to O. M. SMITH.

The Pennsylvania State College, State College, Penna.—6 to 10 Graduate Assistantships ($800 and exemption from tuition and laboratory fees); 5 to 10 Graduate Scholarships which carry exemption from tuition and laboratory fees, 6 to 9 Research Fellowships requiring no service ($800 to $1500 and exemption from tuition and laboratory fees); 2 to 4 full-time Research Assistantships ($1500 to $1700). Address inquiries to FRANK C. WHITMORE.

Princeton University, Princeton, N. J.—12 Part-Time Assistantships ($650). Address inquiries to N. H. FURMAN.

4 full-time Fellowships ($600–1000). Address inquiries to the DEAN OF THE GRADUATE SCHOOL.

Purdue University, Lafayette, Ind.—8 Teaching Fellowships ($800 plus laboratory fees and breakage.) Preference to men with master's degree or at least one year of graduate work. Address inquiries to R. B. MOORE.

Rensselaer Polytechnic Institute, Troy, N. Y.—12 Fellowships ($600 and exemption from tuition and all other fees); several Scholarships ($300). No teaching required. Address inquiries to THE DIRECTOR.

Rhode Island State College, Kingston, R. I.—6 Undergraduate Assistantships ($100 without exemption from fees). Holders required to assist in laboratory and to correct notebooks and papers to an extent of approximately 200 hours. Address inquiries to J. W. INCE.

Rice Institute, Houston, Tex.—7 Graduate Fellowships ($750 and exemption from all fees). Six hours of laboratory teaching per week required. Address inquiries to HARRY B. WEISER.

Rutgers University, New Brunswick, N. J.—7 Full-Time Assistantships ($1000). Address inquiries to W. T. READ.

St. Louis University School of Medicine, St. Louis, Mo.—5 Graduate Assistantships in the department of chemistry ($500–1000, with exemption from tuition). Ten to twelve hours per week of laboratory instruction required. Address inquiries to L. F. YNTEMA.

5 Graduate Assistantships in department of biochemistry ($500–1000, with exemption from tuition). Ten to twelve hours per week of laboratory instruction required. Address inquiries to E. A. DOISY.

Smith College, Northampton, Mass.—2 Part-Time Assistantships ($800 for first year and $900 for second, and exemption from tuition and breakage fees). Twenty hours per week required in laboratory supervision and correction of papers. Address inquiries to C. PAULINE BURT.

South Dakota State College, State College Station, Brookings, S. D.—Part-Time Assistantship ($600 without exemption from tuition of $80). Eighteen hours' laboratory supervision in general or elementary organic required. Address inquiries to B. A. DUNBAR.

Stanford University, Stanford University, Calif.—Shell Research Fellowship, endowed by the Shell Development Co. ($900); du Pont Fellowship, endowed by the E. I. du Pont de Nemours Co. ($750); McCallum Research Fellowship, endowed by the American Rubber Producers, Inc. ($1000); Edward Curtis Franklin Fellowship ($500); Windt Scholarship in chemical engineering ($400); John Maxson Stillman Scholarship ($200); 3 Teaching Fellowships ($750); and a number of Teaching Assistantships (varying in compensation according to the service rendered). Address inquiries to ROBERT E. SWAIN.

There are a number of University Fellowships ($400–750) open to graduate students in all departments. Address inquiries to the DEAN OF THE GRADUATE SCHOOL.

The State College of Washington, Pullman, Wash.—6 Teaching Fellowships, requiring 12 to 15 hours per week assisting in the laboratory ($700 first year, $800 the second year), fees nominal. Address inquiries to C. C. TODD.

1 Research Fellowship in biochemistry ($600 for twelve months). Address inquiries to J. L. ST. JOHN.

State University of Iowa, Iowa City, Ia.—3 Scholarships ($200–300); 4 Fellowships ($300–800); 3 Research Assistantships ($600 or more); 12 Graduate Assistant-

ships ($350); and 16 Graduate Assistantships ($700). Address inquiries to EDWARD BARTOW.

Syracuse University, Syracuse, N. Y.—16 Graduate Instructorships ($750–900 with exemption from all fees); a limited number of Fellowships ($500 with exemption from all fees); a limited number of Scholarships which carry exemption from fees. Address inquiries to R. S. BOEHNER.

Tufts College, Boston 57, Mass.—1 Fellowship ($1000 and exemption from tuition); several Graduate Assistantships ($300, free tuition and free use of apparatus and chemicals). Address inquiries to FRANK W. DURKEE.

Tulane University, New Orleans, La.—1 Part-Time Instructorship ($600); 2 Graduate Assistantships ($450); 1 Graduate Assistantship ($400); 2 Student Assistantships ($300); 1 Student Assistantship ($200). All of the above carry free tuition and the remission of laboratory fees in the Graduate School. Address inquiries to H. W. MOSELEY.

Union College, Schenectady, New York.—1 Part-Time Assistantship ($300 and exemption from tuition and all fees). Approximately one-fourth time required for correcting reports and problems in physical and assisting in analytical chemistry laboratory. Address inquiries to EDWARD ELLERY.

University of Akron, Akron, Ohio.—3 Fellowships in rubber chemistry ($1000 with exemption from tuition, fees, and deposits). Nine hours a week required of the holder in laboratory supervision. Address inquiries to H. E. SIMMONS.

University of Alabama, University, Ala.—3 Assistantships ($675); two pure research and one teaching and research. Address inquiries to STEWART J. LLOYD.

The University of Arizona, Tucson, Ariz.—4 Graduate Assistantships ($600 with exemption from tuition and laboratory fees). Twelve to fourteen hours per week required in laboratory supervision, grading notebooks, papers, etc. Address inquiries to CHAIRMAN, DEPARTMENT OF CHEMISTRY.

University of Arkansas, Fayetteville, Ark.—1 or more half-time Assistantships ($600) and 1 or more fourth-time Assistantships ($300). Address inquiries to HARRISON HALE.

University of Buffalo, Buffalo, N. Y.—3 Scholarships ($750 and exemption from tuition). Six to eight hours' teaching required per week. Address inquiries to A. P. SY.

University of California, Berkeley, Calif.—20 Fellowships and Teaching Fellowships. (These positions net about $650 after all fees are paid.) Address inquiries to G. N. LEWIS.

University of Chicago, Chicago, Ill.—1 Fellowship ($1200); 6 Fellowships ($750–1000); 5 Fellowships ($400–700); 2 Fellowships ($200–250); 1 Research Assistantship ($960); 3 Research Instructorships ($2400–3000) and four Research Fellowships ($2400–3000) open only to those holding a Ph.D. degree; 4 Assistantships ($900); 5 Assistantships ($600); 5 Junior Assistantships ($500). All students are required to pay the graduate tuition fees of $100 per quarter. This, however, is included in the stipends given above. Address inquiries to JULIUS STIEGLITZ.

University of Cincinnati, Cincinnati, Ohio.—2 Fellowships ($500); 2 Laws Fellowships ($500–750); all with exemption from tuition and laboratory fees. There are other Fellowships and Scholarships open to applicants in all departments of the Graduate School. Address inquiries to LOUIS T. MORE, *Dean* of the Graduate School.

In addition, there are also twenty Graduate Assistantships ($500–600, with exemption from tuition and laboratory fees), allotted in the Departments of Chemistry and Chemical Engineering. Address inquiries concerning these Assistantships to H. SHIPLEY FRY, department of chemistry or R. S. TOUR, department of chemical engineering.

University of Colorado, Boulder, Colo.—4 Assistantships ($925); 11 Assistantships ($725). Address inquiries to JOHN B. EKELEY.

University of Delaware, Newark, Del.—1 du Pont Fellowship ($300); 3 Part-Time Assistantships. Address inquiries to A. S. EASTMAN.

University of Florida, Gainesville, Fla.—6 Fellowships ($500 and exemption from tuition); 12 Student Assistantships. Address inquiries to TOWNES R. LEIGH.

University of Illinois, Urbana, Ill.—About 15 Teaching Assistantships of two types: half-time ($600) and quarter-time ($300). Address inquiries to ROGER ADAMS.

1 Carr and 1 du Pont Fellowship ($750 each); Scholarships for first-year graduates ($300); Fellowships for second-year ($400) and third-year graduate students ($500). All appointments carry exemption from tuition and laboratory fees and other university expenses excluding, however, the matriculation fee of $10.00. Address inquiries to A. H. DANIELS, *Dean* of the Graduate School.

University of Kansas, Lawrence, Kans.—11 Fellowships for graduates of Kansas colleges (1 to each college) ($400); 12 University Fellowships ($400). Address inquiries to E. B. STOUFFER.

11 Part-Time Graduate Assistantships ($400–1000). Address inquiries to H. P. CADY.

University of Louisville, Louisville, Ky.—1 Special Fellowship ($300) for students interested in industrial work; 1 Fellowship ($500) for students interested in physiological chemistry; 3 half-time Assistantships ($500 plus tuition). Address inquiries to A. W. HOMBERGER.

University of Maine, Orono, Me.—2 Teaching Fellowships ($500). Several part-time laboratory assistantships, payment made on basis of time spent in laboratory instruction and in grading laboratory notes. There is also available a fund from which loans can be made to students who have demonstrated marked ability and need some financial assistance. Address inquiries to C. A. BRAUTLECHT.

University of Maryland, College Park, Md.—Several Teaching Fellowships ($500 and $1000 and exemption from tuition but not breakage fees). Two afternoons in the laboratories and 5–6 hours in correcting papers and in preparing reagents required of the holder of a $500 Fellowship. Four afternoons in laboratories and 10 to 12 clock hours in departmental service required of the holder of a $1000 Fellowship. Address inquiries to L. B. BROUGHTON.

University of Michigan, Ann Arbor, Mich.—16 Teaching Assistantships ($800–1000); 1 Lecture Assistantship ($800); 1 du Pont Fellowship ($750); 1 Prescott Fellowship in organic chemistry ($200–400); 1 University Fellowship ($500–600); 1 Scholarship ($200–300). Address inquiries to MOSES GOMBERG.

University of Minnesota, Minneapolis, Minn.—1 du Pont Fellowship ($750); 1 Shevlin Fellowship ($500); 30 Teaching Assistantships ($750 or $650 without one year's previous experience as assistant). Both laboratory and university fees are remitted to holders of these positions. Address inquiries to S. C. LIND.

The University of Mississippi, University, Miss.—2 Graduate Fellowships ($300 with remission of laboratory fees), 12 hours work per week required; 6 Student Assistantships ($150 with remission of laboratory fees), open to graduate and undergraduate students, 6 hours work per week required; 2 Stockroom Assistantships ($500 with remission of laboratory fees and room furnished in chemistry building), continuous duty. Address inquiries to G. H. WOOLLETT.

University of Missouri, Columbia, Mo.—1 University Fellowship ($600); 1 University Scholarship ($300); 15 Graduate Assistantships ($600–700). Address inquiries to HERMAN SCHLUNDT.

University of Nebraska, Lincoln, Neb.—Several Scholarships ($350–500); several

Fellowships ($500–750); 5 Research Fellowships for study of arsenic compounds ($600). All carry exemption from tuition and an allowance for chemicals and breakage. Address inquiries to F. W. UPSON.

University of Nevada, Reno, Nev.—1 Teaching Fellowship ($600). Address inquiries to G. W. SEARS.

University of North Carolina, Chapel Hill, N. C.—3 Teaching Fellowships ($500); 5 Assistantships ($750); 6 Assistantships ($500); 1 Fellowship ($300). Address inquiries to JAMES M. BELL.

University of Notre Dame, Notre Dame, Ind.—7 Graduate Assistantships ($750 each); 1 non-teaching Research Fellowship ($750 plus free tuition); 2 Teaching Fellowships ($1000 each). Address inquiries to HERMAN H. WENZKE.

University of Oregon, Eugene, Ore.—3 Graduate Fellowships ($500 first year, $600 second); 4 Half-Time Fellowships ($25 per month for nine months). Exemption from tuition but from no other fees for both. Twenty clock hours required of full-time Fellows, ten of half-time. Duties include assisting in laboratory, reading papers, etc. Address inquiries to O. F. STAFFORD.

University of Pennsylvania, Philadelphia, Penna.—Several University Scholarships and Fellowships ($200–1000); 2 Research Fellowships open only to holders of Ph.D. degree ($1500). Address inquiries to H. LAMAR CROSBY.

University of Pittsburgh, Pittsburgh, Penna.—6 Graduate Assistantships ($800 and exemption from tuition fees). Address inquiries to A. SILVERMAN.

University of Tennessee, Knoxville, Tenn.—5 Teaching Fellowships ($500 and remission of all tuition fees except $25, which covers the student activity fee, health and library fees). Address inquiries to CHARLES O. HILL.

University of Texas, Austin, Tex.—24 Tutorships ($725, 800, and 1000) and Assistantships ($550). Address inquiries to H. R. HENZE.

University of Utah, Salt Lake City, Utah.—6 Teaching Fellowships ($500 without exemption from fees, amounting to about $70); 1 Storeroom Assistantship ($400). Address inquiries to W. D. BONNER.

University of Vermont, Burlington, Vt.—A number of University Fellowships ($700–800 and exemption from tuition fees). Address inquiries to G. H. BURROWS.

University of Virginia, University, Va.—A number of University Fellowships not specifically allocated to individual departments; 1 Fellowship ($750 and exemption from tuition); 13 Teaching Fellowships ($650–750 and exemption from tuition). Assistance, not exceeding 15 hours per week in undergraduate courses, required of Teaching Fellows. Address inquiries to SECRETARY, CHEMISTRY FACULTY.

University of Washington, Seattle, Wash.—18 Teaching Fellowships ($720). Address inquiries to GEORGE MCP. SMITH.

University of Wisconsin, Madison, Wis.—3 University Fellowships ($750); 1 du Pont Fellowship ($750); 1 or 2 University Scholarships ($250); 1 Special Scholarship for women only ($300); 4 or 5 Private Research Assistantships ($600); 5 or 6 Senior Assistantships ($1000–1200); 10–15 Junior Assistantships ($600–800). Address inquiries to J. H. MATHEWS.

University of Wyoming, Laramie, Wyo.—2 Graduate Assistantships ($600). Address inquiries to P. T. MILLER.

Vanderbilt University, Nashville, Tenn.—3 Fellowships ($500 and exemption from breakage fees); 3 Scholarships ($300 and exemption from breakage fees); Eagen Fellowship ($800 and exemption from laboratory fees). Address inquiries to J. M. BRECKENRIDGE.

Virginia Polytechnic Institute, Blacksburg, Va.—4 Fellowships ($400–750). Address inquiries to J. W. WATSON.

Washington University, St. Louis, Mo.—8 Assistantships ($750 with exemption from tuition and laboratory fees, and allowance for breakage); 1 Industrial Fellowship ($500 to $750 with similar exemption from fees); several University Fellowships ($500), and Scholarships ($200 with similar exemption from fees). Address inquiries to L. McMASTER.

Wellesley College, Wellesley, Mass.—1 Part-Time Assistantship ($550 with exemption from tuition). Duties required are preparation for lectures and laboratories. Address inquiries to HELEN S. FRENCH.

Wesleyan University, Middletown, Conn.—4 to 6 Half-Time Assistantships ($600 first year, and $800 second year, plus exemption from tuition and charges for breakage); 2 Industrial Fellowships, with limited teaching duties. Address inquiries to DEPARTMENT OF CHEMISTRY.

West Virginia University, Morgantown, W. Va.—6 Graduate Assistantships ($650); 4 Graduate Fellowships (approximately $500); 1 Graduate Assistantship ($1200); 3 Fellowships ($1200). Address inquiries to FRIEND E. CLARK.

Western Reserve University, Cleveland, Ohio.—1 Jeavons Fellowship ($1200); 1 Cushman Fellowship ($750); 2 Ohio Chemical Manufacturing Company Fellowships ($900); 1 Scholarship ($500). All of these positions carry exemption from tuition and laboratory fees. 3 Assistantships ($600–1000 and free tuition). Address inquiries to E. J. BENTON, *Dean* of the Graduate School.

Williams College, Williamstown, Mass.—2 Part-Time Assistantships ($1200 and exemption from tuition and fees). General assistant work required in general, qualitative, organic, and physical. Address inquiries to BRAINERD MEARS.

Worcester Polytechnic Institute, Worcester, Mass.—2 Part-Time Assistantships ($750 and exemption of one-half of $280 tuition). Supervision required in five three-hour laboratory periods per week. Address inquiries to W. L. JENNINGS.

Yale University, New Haven, Conn.—Several Assistantships ($850–1000, without remission of tuition, laboratory fees, and breakage amounting to about $350); several Scholarships and Fellowships that are usually reserved for Ph.D. degree candidates in the final year; the Loomis Fellowship ($1500). Address inquiries to ARTHUR J. HILL.

J. T. BAKER CHEMICAL COMPANY ANALYTICAL RESEARCH FELLOWSHIPS FOR 1931–32

PREAMBLE

Progress in chemistry has been so rapid and carried to such a degree of specialization in certain directions that there is need to halt momentarily and consider its effects.

To a great extent the real progress in science is dependent upon precision methods of measurement. Analytical chemistry, particularly quantitative, is the principal instrument of measurement of chemical science. Although great advance has been made in this branch of chemistry, it has not kept pace with the progress made in the other branches, and the latter are demanding more and more precise quantitative methods. Important and useful as these other advances may be, they nevertheless have done much to detract attention from the fundamental importance of pure research in analytical chemistry.

Active participation in the research development of a subject is one of the prerequisites to the successful teaching of that subject. It is felt that institutions of learning should place the teaching of both elementary and advanced quantitative chemistry in charge of men with due regard to special fitness, love, and desire for this branch of chemistry.

Analytical chemistry, though the oldest and one of the most useful branches of chemistry, has descended from its former position of respect and undoubted potency and influence in the development of chemistry because of the glamour of publicity attached to research in new fields; because of the lack of capable and inspirational teachers in analytical chemistry; and because of the occasional conception that this branch of chemistry is too much like the A, B, C of one's career in the field of chemistry.

Extensive progress in certain fields of chemistry has focused attention on the present status of analytical chemistry by the demand made for products requiring fine precision methods of measurement for the constituents contained in them. Biological, metallurgical, and other scientific investigations requiring a study of the effect of minute quantities of this or that element, and its combinations upon the problem at hand, force upon us the necessity of finding better and more reliable methods for their measurement. Indeed, progress is often arrested pending improved analytical technic.

Believing in the fundamental importance of pure research in analytical chemistry for the further development of chemistry as a whole, and desiring to encourage study in this branch of chemistry as a teaching major, the J. T. Baker Chemical Co. has established several fellowships to the value of one thousand dollars ($1000.00) each a year.

Eastern Division

1. The fellowship shall be known as the J. T. Baker Chemical Company Eastern Fellowship for Research in Analytical Chemistry.

2. The fellowship will be granted to an advanced student in analytical chemistry for study in an institution conferring the doctor's degree in chemistry in the New England States, New York, Pennsylvania, New Jersey, Delaware, or Maryland.

3. The objects of this fellowship are to develop fundamental research in the quantitative estimation of inorganic components as distinguished from routine application of established methods; to encourage such research; and, in general, to develop reliable precise chemical measurement.

4. The holder of this fellowship will receive $1000 annually. Ordinarily, the fellowship will not be awarded to the same candidate for two years in succession.

5. The fellowship may begin in the autumn or in a summer session and

each candidate will be expected to devote at least nine months to the research.

6. A candidate for this fellowship must possess the following qualifications:

(*a*) A bachelor's degree or its equivalent.

(*b*) A broad training in the fundamental branches of chemistry, including inorganic, organic, and physical chemistry as well as qualitative and quantitative analysis.

7. In awarding this fellowship preference will be given to those who have already had experience in research in chemistry.

8. Application for the coming academic year should be made before February 15th to the chairman of the committee and should include the following information:

(*a*) Age.

(*b*) Degrees.

(*c*) Previous training in chemistry.

(*d*) Outline of proposed problem.

(*e*) Name of person under whose direction work is to be done. It is understood that the applicant will ascertain the requirements of the institution where the work is to be done. Consideration of the applications will be facilitated if five copies are sent.

9. Within a month after the end of the academic year for which the fellowship is awarded the holder of the fellowship shall send to the committee and to the J. T. Baker Chemical Co. a report of work accomplished during the year, and it is expected that the results of the work will be published in the journals of the American Chemical Society within a reasonable time.

10. Information on points not covered by the articles above may be obtained from the committee:

N. HOWELL FURMAN, Princeton University, *Chairman*
PHILIP E. BROWNING, Yale University, *Secretary*
GREGORY P. BAXTER, Harvard University
E. M. CHAMOT, Cornell University
H. A. FALES, Columbia University

Mid-Western Division

1. This fellowship shall be known as the J. T. Baker Company Fellowship in Analytical Chemistry.

2. The object of this fellowship is to emphasize the need of fundamental research in inorganic analytical chemistry, particularly quantitative, as distinguished from routine application of established methods; to en-

courage such research and, in general, to develop reliable precise chemical measurement.

3. This fellowship is limited to institutions which grant the doctor's degree in chemistry in the states of Illinois, Indiana, Iowa, Michigan, Minnesota, Ohio, and Wisconsin.

4. The holder of this fellowship will receive $1000 annually. In addition it should be noted that nearly all the institutions to which it is limited remit laboratory fees to the holders of such fellowships and many of them also remit tuition fees. This adds greatly to the value of such fellowships and it is hoped that all the institutions concerned will eventually see fit to remit all fees to the fellow.

5. In awarding this fellowship preference will be shown (*a*) to those institutions which have a background of research in inorganic analytical chemistry; (*b*) to projects sponsored by the division of analytical chemistry; (*c*) to candidates desiring to follow the teaching profession.

The fellowship will not ordinarily be awarded to a given institution for two or more years in succession.

6. An application for an award of this fellowship may be sent by any member of the teaching staff who is qualified in his institution for supervising a doctor's dissertation.

The application shall include (*a*) an outline of the proposed problem, (*b*) a sketch of the experimental evidence upon which the merits of the problem are based, (*c*) a statement of the qualifications of the candidate. Applications must be sent before February 15th to the chairman of the committee. (Consideration of the applications will be facilitated if five copies are sent.)

7. This fellowship will usually be awarded to students specializing in analytical chemistry who have completed all or nearly all of their course work and can devote practically their full time to the doctor's dissertation.

8. The fellowship may begin in the autumn or in the summer session.

9. As soon as the research work carried out under this fellowship has been completed, an account thereof shall be sent to the J. T. Baker Chemical Company, and the work shall be published within a reasonable time.

10. Information on points not covered by the articles above may be obtained from the committee.

H. H. WILLARD, University of Michigan, *Chairman*
C. W. FOULK, Ohio State University
STEPHEN POPOFF, Iowa State University
G. F. SMITH, University of Illinois
I. M. KOLTHOFF, University of Minnesota

God never imposes a duty without giving the time to do it.—RUSKIN

Correspondence

CENTIGRADE-FAHRENHEIT TEMPERATURE CONVERSION

DEAR EDITOR:

In the December issue of the JOURNAL OF CHEMICAL EDUCATION, page 2946, I noticed a topic headed as above by JOSEPH G. BLANN, David Starr Jordan High School, Los Angeles, California.

What appears to the present writer to be a more simple means of conversion is the following:

(1) To Centigrade add 40° multiply by 9/5 and subtract 40°
or To Fahrenheit add 40° multiply by 5/9 and subtract 40°.

In either case add 40° at the beginning and subtract 40° at the end. If one is going from low to high (C. to F.), multiply by the improper fraction, 9/5. Or if one is going from high to low (F. to C.), multiply by the proper fraction, 5/9. There is really no formula to get wrong and this is the easiest method I have ever seen for converting one temperature into another.

(2) Another easy conversion is to take as a basis 20°C. equals 68°F. With that one can change C. to F. by solving how 20°C. equals 68°F. 20°C. multiplied by the improper fraction, 9/5, and 32° added to the result is the only way 20°C. can equal 68°F. This being true then, one always has a ready means for conversion. By working this backward one can go from F. to C., thus

$$68°F. - 32° = 36° \times 5/9 = 20°C.$$

Other numbers, for example, 100°C. and 212°F., could be used instead of 20°C. and 68°F.

ALFRED M. EWING*

THE OHIO STATE UNIVERSITY
COLUMBUS, OHIO

* Graduate student, physical chemistry.

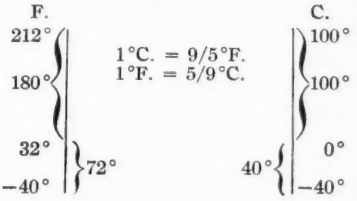
DEAR EDITOR:

The December issue of the JOURNAL OF CHEMICAL EDUCATION carried an article on pages 2946–7 by JOSEPH G. BLANN, on the topic of conversion of Centigrade to Fahrenheit by referring to the boiling point of water, instead of the freezing point of water as the standard texts employ. This article created a great deal of interest for me, because I felt it was just as difficult to remember to use 212° and 100° as boiling points and substract the correct numbers at the right time, as in this illustration: 20°C. = ?°F.

20°C. is (100 − 20) 80°C. below the boiling point. Therefore, take 9/5 X 80 = 144°F. below the boiling point or 212° − 144° = 68°F.

I believe most problems will be dropped with the answer 144°F. instead of 68°F.

For the past ten years I have been using and teaching a conversion scheme that seems to satisfy the need as well as to satisfy the student. The standard point of conversion in this scheme is −40°C. equals −40°F.



Therefore, if I were to change 20°C. to F., the plan is to add 40, multiply by 9/5, subtract 40 and the result is 68°F. Also to change 68°F. to ?°C., the plan is to add 40, multiply by 5/9, subtract 40, and the result is 20°C. To state these plans in algebraic formulas

$$F = (C + 40)\ 9/5–40$$
$$C = (F + 40)\ 5/9–40$$

for the algebra student is advisable.

This little puzzle of changing temperature scales in science classes causes very little fear and worry for students and teachers in our high-school science department.

Since the standard texts use the old 32° plan of conversion, the origin of the −40° plan cannot be indicated, in spite of the fact that it has been used for ten years producing successful and pleasant results.

HERMAN W. WOODS

GARFIELD HIGH SCHOOL
CLEVELAND, OHIO

A SHOW WINDOW FOR THE CHEMISTRY DEPARTMENT

DEAR EDITOR:

We hear it said that every teacher must be a salesman, selling his subject. What more legitimate, then, than a salesman's show-window?

I wished for one for several years. Interesting things are brought, or develop on our hands, and only a favored few see them ordinarily. Last year I removed a "dead" exhibit of zinc plant "intermediates" from a case in the hallway outside my door, put in a lamp-bulb, and every few days introduced a "live" exhibit. There were a "chemical garden," surface tension boats, Geissler and X-ray bulbs which worked with a push-button, a rock that floated on water (volcanic tufa), a density exhibit with mercury,

iron, carbon disulfide, and so on. The students liked it. They talked about it and asked questions. Isn't that a desirable result?

Accordingly, in our new high-school building, provision was made for it in the form of a real display window. It opens from the stockroom just like a show window in a store, is easily accessible for changing exhibits, presents a neater appearance than a case standing in the hallway as the old one did: and the light it affords makes a bright, inviting spot in what would be otherwise a dark stretch of hall. Exhibits are not difficult to furnish and all the students in school get around to see what we have.

RICHARD L. FELDMAN

SENIOR HIGH SCHOOL
DONORA, PENNA.

Sodium Now Cheap as Iron. If you had to fill a cubic foot of space with some metal, which metal would cost least? Iron, maybe; but, if as much as a car load were bought, the now rare and very active sodium would be a few cents cheaper, a little less than $11.50 per cubic foot.

Revelation of the fact that sodium, the metal of extreme purity, remarkable chemical activity, and low electrical resistance, costs so little by volume is made in a comparison of prices of metals in a recent issue of *Metals and Alloys*.

Nickel is the most expensive common metal by the cubic foot, that volume costing $192.50. The same measure of ten sells commercially for $143.75; copper, $72.50; aluminum, $39.50; lead, $39; antimony, $31.50; zinc, $22; and ingot iron and sodium, $11.50.

Although sodium is now as cheap as iron, if more uses for it were found it might be produced in quantity for a third the present cost. Its occurrence, in close chemical combinations with other elements is common. Electrical decomposition is necessary to separate it.

Unlike most metals, sodium is so active chemically that to be kept pure it is immersed in kerosene. In air a film of oxide immediately forms on its surface. It is slightly lighter than water and melts a trifle below the boiling point of water.

In spite of the fact that sodium cannot be strung from pole to pole and, even if it could, it would be quickly eaten away by the oxygen of the air, it might actually be used as a much cheaper and more efficient conductor of electricity than copper, *Metals and Alloys* speculates. A sodium conductor need be only a third the weight of a copper conductor to carry the same electricity, though it would be three times as large. At prices for sodium which would prevail if such conductors came into use, it would cost only a fraction as much as the equivalent of copper.

"If we filled a thin copper or austenitic stainless steel tube, strong enough to carry the load," the article continues, "with sodium, and could make provision to avoid difficulties from the high coefficient of expansion of sodium, from the likelihood that it would creep down into the sag of the cable if we left space inside the tube for expansion, and from the danger that would ensue if such a conductor did break, and could work out the problem of making joints and connections, we should have a cheaper conductor than either solid copper or aluminum. Crazier things have been done."

Sodium is now used chiefly as a modifier in aluminum-silicon alloys and as a hardener for lead. The chemist makes it 99.9 per cent pure; certainly the metallurgist can find more uses for such a metal, the article challenges.—*Science Service*

Chemical Digest

SCIENCE MAKES MARKED PROGRESS DURING 1930

Among the many important developments of science during 1930 as listed by *Science Service* were:

Chemistry

The existence of rotating molecules in solid compounds was reported by PROF. LINUS PAULING, of the California Institute of Technology, and DR. STERLING B. HENDRICKS, of the Fixed Nitrogen Laboratory, U. S. Department of Agriculture; this discovery has an important bearing on the heat capacities of solids.

The magnetic susceptibility of samarium sulfate octohydrate was announced by SIMON FREED of the University of California, arousing great interest among chemists because the discovery indicates the possibility of electronic isomers in the solid state.

The chemical puzzle of the structure of the crystal of the silicates was solved by WILLIAM L. BRAGG, Victoria University of Manchester, England, and PROF. LINUS PAULING, of the California Institute of Technology.

A new gas for use in electric refrigerators, non-poisonous and non-inflammable, which is a compound of carbon, chlorine, and fluorine, was the invention of THOMAS MIDGLEY, JR.

Carotin, the stuff that makes some foods yellow, is important for nutrition as well as the green chlorophyll, because vitamin A is associated with this color in vegetables, butter, and egg yolk, it was discovered by S. M. HAUGE and J. F. TROST of the Purdue University Agricultural Experiment Station.

Bacteria obtained from brewer's malt may now be pressed into the service of the chemist to eat away the cell walls of plant tissue and liberate the vegetable oil, according to a method developed by JOHN WOODS BECKMAN, Oakland industrial chemist.

A device for removing carbon monoxide from the exhaust gases of an automobile by means of a catalyst was demonstrated by the inventor, Dr. J. C. W. FRAZER of The Johns Hopkins University.

The richest source of helium yet discovered, a natural gas in southeastern Colorado containing seven per cent of helium, was reported by F. F. HINTZE, of the University of Utah.

Crystals of rubber were obtained for the first time in the chemical laboratories of the U. S. Bureau of Standards.

The U. S. Pharmacopeial Convention, which meets once in ten years to

decide on the contents of the Pharmacopeia or standard for drugs and chemicals, met in Washington in May.

Arsenic and germanium are both present in some meteorites that fall to the earth, it was discovered by DR. JACOB PAPISH and ZAIDA M. HANFORD, Cornell University chemists.

Engineering

After a third attempt, PROF. GEORGES CLAUDE was successful in obtaining power from the temperature difference in the ocean water at the surface and in the depths of the tropical seas off the Cuban coast.

Application of the hydrogenation of crude oil, which greatly increases the production of gasoline, was extended.

The city gas business was further invaded by natural gas and its by-products, propane and butane, and petroleum refinery gas; natural gas being piped as far as 1000 miles to centers of population.

The application of welding to steel building construction was greatly extended, the number of such buildings being increased 50 per cent.

The world's first metal base highway was laid as an experiment in Illinois.

Photographic films taken by the Andrée polar balloon expedition more than 30 years ago were found with the explorers' remains and developed and printed successfully in spite of deterioration by age and exposure.

Medicine

A hormone from the cortex of the suprarenal glands was isolated by DRS. W. W. SWINGLE and J. J. PFIFFNER of Princeton University and used by DRS. LEONARD G. ROWNTREE and C. H. GREENE of Mayo Clinic to treat hopeless victims of Addison's disease, in the same way that insulin affects the coma of diabetes. DRS. F. A. HARTMAN and K. A. BROWNELL of the University of Buffalo also obtained an extract of the same gland.

The filterable virus germ which causes multiple sclerosis, or "creeping paralysis," was discovered with the aid of a special ultramicroscope at a magnification of 1800 diameters by SIR JAMES PURVES-STEWART and KATHLEEN CHEVASSUT of the Westminster Hospital, London.

An artificial lung or respirator was invented by DRS. PHILIP DRINKER and L. A. SHAW of the Harvard School of Public Health to keep alive patients whose breathing muscles are paralyzed in infantile paralysis or who are victims of gas poisoning.

A new method for studying the miscroscopic growth of living tissue in a warm-blooded animal was developed at the University of Pennsylvania School of Medicine.

An enzyme which has both protective and curative action on Type III pneumonia in mice, and possibly also in man, was extracted from a bacillus found in the soil of New Jersey cranberry bogs.

Vitamins in sufficient amounts will prevent infection of animals, and possibly man, with leprosy, it was reported by DR. J. SHIGA, dean of the Imperial Medical Faculty, Seoul, Korea.

The National Institute of Health was created by act of Congress replacing the Hygienic Laboratory of the U. S. Public Health Service.

A new species of the meningococcus organism, cause of meningitis, was found by investigators of the U. S. Public Health Service.

Cancer studies were reported by numerous investigators. DRS. WALTER B. COFFEY and JOHN B. HUMBER of San Francisco announced a method of treating cancer by injection of a glandular extract. DRS. SHIGEMITSU ITAMI and ELLICE MCDONALD of the University of Pennsylvania reported they were unable to cure cancer in mice by this method. DR. FREDERICK S. HAMMETT of Philadelphia found that the application of partly oxidized sulfur compounds caused tumors in mice to disappear.

Postgraduate demonstrations of cancer, in which radiologists, pathologists, and other specialists tested and increased their diagnostic ability, were held under the auspices of the Surgical Pathological Laboratory of The Johns Hopkins University.

Experiments proving that the common cold is caused by a filterable virus were reported by two groups of investigators: DR. GERALD S. SHIBLEY, KATHERINE C. MILLS, and DR. A. R. DOCHEZ of the Columbia University College of Physicians and Surgeons and the Presbyterian Hospital of New York; and DRS. PERRIN H. LONG and JAMES A. DOULL of The Johns Hopkins Medical School.

An extensive outbreak of psittacosis, popularly known as parrot fever, occurred in the United States and many other countries. In this country 169 cases with 33 deaths were reported. Investigators of the U. S. National Institute of Health made an extensive study but did not find the *Bacillus psittacosis* which a French scientist, E. Nocard, had reported as the causative germ in 1892. They concluded that the disease was caused by a filterable virus. They did find an organism which might be the cause of the disease, but it was not *B. psittacosis* or any other member of that germ family.

A phenol compound, tri-ortho cresyl phosphate was found by the U. S. Public Health Service to be the adulterant which caused thousands of cases of partial paralysis from drinking bootleg Jamaica ginger, known as "ginger jake."

A new chemical method of standardizing ergot, widely used in childbirth, was devised by DR. M. I. SMITH of the National Institute of Health, formerly the U. S. Hygienic Laboratory.

The time required for blood to clot, vitally important in surgical operations, is shortened by feeding the patient vitamin D, it was discovered.

Study of the chemical changes taking place in the brain was made

possible for the first time through a technical procedure developed by DR. ABRAHAM MYERSON of Boston whereby blood is taken from the artery leading to the brain and from the vein which drains the brain, and the chemical contents of the two samples compared.

New hope for recovery of child victims of serious burns was given by a treatment, making use of a tannic acid solution, devised by DR. EDWARD C. DAVIDSON of Detroit.

Radio waves, shorter than those commonly used for sending messages, are able to weaken materially the poison elaborated by the diphtheria bacillus, it was discovered by DRS. WACLAW T. SZYMANOWSKI and ROBERT ALAN HICKS of the Western Pennsylvania Hospital Institute of Pathology.

A new method for measuring the heart's output of blood by determining the amount of acetylene gas taken up by the lungs in a certain time was devised by DR. ARTHUR GROLLMAN of The Johns Hopkins University.

The three hundredth anniversary of the first use of cinchona bark, from which quinine is obtained for the treatment of malaria, was celebrated.

A new barbituric acid derivative, the sodium salt of isoamylethylmalonylurea, was discovered and found to be valuable to the surgeon in producing a state just short of deep sleep.

Calcium gluconate, formerly only a laboratory curiosity, was discovered to be an effective medicine.

Physics

The theory that the sun is lighted like a giant electric bulb by electricity under pressure of ten million volts flowing from inside the sun and heating its atmosphere to incandescence, was advanced by DR. ROSS GUNN, U. S. Naval Research Laboratory.

A new physical concept, the paradoxical one that two separate particles of matter can be completely identical, was enunciated by PROF. GILBERT N. LEWIS of the University of California.

That space is not empty but filled with electrons of minus or negative energy was suggested by DR. P. A. M. DIRAC of Cambridge University, England.

A new theory of the universe, assuming that it is non-static and consisting of matter dissipating through radiation, was propounded by DR. RICHARD C. TOLMAN, of the California Institute of Technology.

The possibility that the whole universe is fading away so that in some timeless future no matter will remain, only radiation, was indicated by calculations made by DR. LOUIS S. KASSEL of California Institute of Technology.

The theory that cosmic rays are not rays at all but high velocity particles was advanced by two German physicists, DR. WALTER BOTHE of Berlin and DR. WERNER KOLHOERSTER of Potsdam, as a result of experiments

they have conducted with a specially built adaptation of the electron counter, but researches of DR. R. A. MILLIKAN on the intensity of cosmic rays near the north magnetic pole provided evidence against the theory.

The theory that cosmic rays consist of high-velocity particles, like tiny bullets, was supported by experiments conducted by DR. L. F. CURTIS of the U. S. Bureau of Standards in which he used two electron counters.

A new type of clock controlled electrically by a vibrating crystal, thus dispensing with a pendulum, has been developed under the direction of DR. W. A. MARRISON of the Bell Telephone Laboratories.

A molded compound, including silicon carbide or carborundum, which has the quality of preventing the flow of electricity at low voltages, while allowing it to pass at high potentials, was developed at the laboratories of the General Electric Company.

Alternating electric current is more dangerous at low voltages than at high, it was discovered through experiments on rats at The Johns Hopkins University; with the ordinary house potential of 110 volts, 100 milliamperes will cause death.

Electric current direct from sunlight was made possible through the invention by DR. B. LANGE, of the Kaiser Wilhelm Institute for Silicate Investigation, of a new type of cell containing copper oxide between two layers of metallic copper.

DR. ERNEST O. LAWRENCE of the University of California, with his associate, DR. N. E. EDLEFSEN, devised a method for increasing the speed and energy of the protons or hearts of hydrogen atoms so that it may be possible when the method is further perfected to use them as atomic projectiles for smashing the hearts of other atoms, transmuting them into other substances or releasing enormous quantities of atomic energy.

A method of taking photomicrographs by long-wave ultra-violet light, through an ordinary glass lens, was discovered by DR. A. P. H. TRIVELLI, of the Eastman Kodak Co., and LEON V. FOSTER, of the Bausch and Lomb Optical Co.

The final value for the most accurate measurement ever made of the constant of gravitation was announced after seven years' work by DR. PAUL HEYL, physicist of the U. S. Bureau of Standards, to be the fraction 6.670 over 100,000,000. (See pages 401–2 of this issue.)

Artificial gamma rays, which may take the place of radium in the treatment of cancer, are produced by a giant vacuum tube operating at 700,000 volts at the California Institute of Technology.

An electric photoflash lamp, a German invention, for taking flashlight photographs without noise or smoke was introduced in the United States, the light being made by aluminum foil ignited electrically in a bulb full of oxygen.

Recognitions and Awards

For his researches on light, particularly the discovery that monochromatic light when scattered by shining on certain transparent substances is partly changed to other colors, SIR CHANDRASEKHARA VENKATA RAMAN, professor of physics at the University of Calcutta, was awarded the Nobel Prize in Physics.

The 1930 Nobel Prize in medicine was awarded to DR. KARL LANDSTEINER of the Rockefeller Institute of Medical Research for the discovery that human blood is of four different types and that blood of one type does not always mix with blood of another type.

The Nobel Prize in chemistry was awarded to PROF. HANS FISCHER of Munich for his achievement in the laboratory production of hemin, one of the components of hemoglobin, the red coloring matter of blood.

DR. GEORGE H. WHIPPLE of the University of Rochester and DR. GEORGE R. MINOT of Harvard University Medical School shared the first $10,000 *Popular Science* annual award given in recognition of their discovery of a successful treatment of pernicious anemia by the liver diet.

The Perkin medal was awarded to the late DR. HERBERT H. DOW, president of the Dow Chemical Company, for his developments of improvements in the production of chlorine, bromine, magnesium, and other chemicals.

The James Douglas Medal of the American Institute of Mining and Metallurgical Engineers was awarded this year to JOHN V. N. DORR, president of the Dorr Company, for "his invention of apparatus and achievement in developing and improving hydrometallurgical practice."

A gold medal and accompanying annuity of from $100 to $500 to be given government workers for scientific achievements was proposed in a bill before Congress.

The William H. Nichols Medal for 1930 was presented by the New York Section of the American Chemical Society to SAMUEL E. SHEPPARD of the Eastman Kodak Company for his "outstanding achievement in the chemistry of photography."

The Willard Gibbs medal was awarded to DR. IRVING LANGMUIR for "fundamental work on atomic hydrogen and on surface relations and also on electrical discharge phenomena; also for his contributions of great importance to nearly all branches of physical chemistry, including high vacuum technic, electronics, thermochemistry and catalysis, and lastly for his presentation of a theory of atomic structure."

The Edison Medal of the American Institute of Electrical Engineers was awarded to PROF. CHARLES F. SCOTT of Yale for his pioneering work in electric transmission.

The Franklin Medal, awarded by the Franklin Institute, was given this

year to SIR WILLIAM BRAGG, director of the Royal Institution of Great Britain.

In recognition of his demonstration that protons act like waves, PROF. ARTHUR J. DEMPSTER. of the University of Chicago, was awarded the $1000 prize given annually by the American Association for the Advancement of Science.

The American Pharmaceutical Association gave its Ebert Prize for 1930 to MARVIN R. THOMPSON of the University of Maryland for his work on the pharmacology of ergot.

Jamming Doors and Windows Combated by Government Chemists. Windows that jam, doors that stick, airplane propellers warped out of balance and shape and the other annoyances and hazards caused by the shrinking and swelling of wood are best prevented by coating the wood with aluminum leaf or by paints, enamels, and varnishes containing aluminum powder, or by impregnating the wood with sugar, George M. Hunt of the Forest Products Laboratory of the U. S. Department of Agriculture states in a report based on fifteen years of researches.

Since the early days of the war, when much trouble was caused by the warping of airplane propellers, government chemists have been working on this problem, which is important alike to housewife, engineer, and inventor. Under the stress of war necessity, the aluminum-leaf process was devised and since that time no more effective process has been discovered. Aluminum paints have, however, been investigated as a substitute and are now recommended by the Forest Products Laboratory in preference to the aluminum leaf for general use. Suitable paints and enamels are nearly as effective and much more convenient to apply.

The secret of the efficiency of aluminum leaf and the various paints, enamels, and varnishes in minimizing the shrinking and swelling of wood lies in their power to exclude moisture. Moisture permeating wood has a tendency to expand its volume and the different coatings reduce this tendency in proportion to their waterproof qualities.

All-metal plate, perfectly riveted and without cracks or airholes, offers the perfect coating to prevent moisture warping of wood but there is little practical use for this sort of armored wood. Metal leaf, particularly aluminum leaf, offers many of the advantages and disadvantages of the metal plate but is more practical for ordinary use.

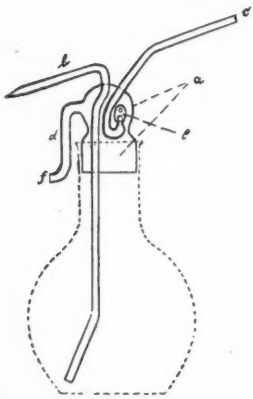
Several secret formula paints show a high degree of impenetrability to moisture but generally speaking the paints and enamels containing aluminum powder rank highest in preventing moisture warping of wood.

Addition of more lead color pigment in paints appeared also to increase the moisture-proof qualities of those containing lead. Increasing the coats of paint was likewise helpful. Impregnating the wood with sugar did not prevent the moisture from penetrating the wood but did in some way reduce the volume change ordinarily caused by dampness.

For the information of woodworkers, paint manufacturers, and ordinary citizens harassed by the temperamental behavior of wood in wet weather, the U. S. Department of Agriculture, Washington, has published a report by George M. Hunt on the "Effectiveness of Moisture-Excluding Coatings on Wood." This is still available for free distribution.—*Science Service*

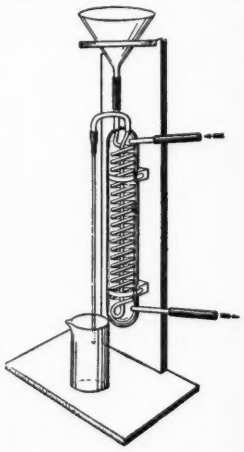
Abstracts

APPARATUS, LABORATORY PRACTICE, AND DEMONSTRATIONS



A Washbottle for Organic, Poisonous, or Corrosive Liquids. W. FERMAZIN. *Chem.-Ztg.*, **54,** 804 (Oct. 15, 1930).—The ordinary washbottle when employed with corrosive, poisonous, or narcotic liquids has the disadvantage that vapors of the liquids will rise to the mouth of the person using the bottle. This disadvantage is avoided in the construction shown. Three tubes *b*, *c*, and *d* are sealed into the glass stopper *a*; *b* is bent at its lower end; a glass valve *e* is sealed to the tubes *c* and *d*. The tube *d* is open at *f* where it is closed with the finger when the bottle is used.

On blowing into the flask the excess pressure drives the liquid through the outlet tube, even when the blowing has been stopped, until the finger is lifted from *f* whereby the pressure is equalized. The presence of the valve prevents any vapors from passing through *c*. The flask can be used for pouring like every ordinary washbottle. L. S.



A Rapid Cooling Apparatus. R. KOHLMANN. *Chem.-Ztg.*, **54,** 764 (Oct. 1, 1930).—The cooler is 300 mm. long. The tubing through which the liquid to be cooled flows has a diameter of 4 mm. and contains 25 spiral turns. The device can be used for qualitative as well as quantitative work. The volume of residual liquid remaining in the apparatus is 2–3 cc. and can be washed out, if necessary, with 40 cc. of water or solution. By means of this apparatus it is possible to cool one-half liter of liquid from 80°C. to 20°C. wthin two and one-half minutes. L. S.

A Distillation Set-Up for Frothing Liquids. *Syn. Org. Chem.*, **4,** No. 2 (1930).—The distilling flask is made from a three-liter, long-neck flask, which is connected by means of a 28-mm. tube to a two-liter, long-neck flask. A trap is sealed into the bottom of the smaller flask and connected with a return tube to the distilling vessel. The remainder of the set-up is the usual condensing receiver attached to the vacuum pump via the safety trap and manometer. H. H. K.

An Outstanding Improvement in Gas Analysis Apparatus. *Laboratory*, **3,** 71 (1930).—This new pipet is built similar to the bubbling pipet, except in it the gas passes through a platinum disc containing about 212 minute holes. By this means the gas is distributed into many separate streams of small bubbles and more complete absorption is effected. (See U. S. Bureau of Standards Research Paper No. 177.) H. H. K.

A Rotating Bunsen Burner Driven by Water Power. *Chem.-Ztg.* **54,** 803-4 (October 15, 1930).—A horizontally rotating Bunsen burner made from cast iron and can be used for 1–6 burners. L. S.

The Determination of Sulfur in Rubber. J. G. MACKAY. *Chem. & Ind.*, **49,** 401T–3T (Oct. 10, 1930).—The method for total sulfur involving the oxidation by means of nitric and phosphoric acids and bromine, followed by volumetric determination as benzidine sulfate, is modified so as to permit the gravimetric determination of sulfuric acid as barium sulfate. Details of the method are given. A method for free sulfur (acetone extraction) is also presented. E. R. W.

TEACHING OBJECTIVES, METHODS, AND SUGGESTIONS

The Ionic-Electronic Methods of Balancing Oxidation-Reduction Equations. H. A. IDDLES. *Rep. New Eng. Assoc. Chem. Teachers*, **32**, 34–40 (Nov., 1930).—The steps to be followed are: (1) ascertain the products of the reaction, (2) set up a partial equation showing the change undergone by the oxidizing agent, (3) set up a partial equation showing the change undergone by the reducing agent, (4) balance each electrically, (5) multiply each partial by a factor so that when the two are added together the electrons just compensate each other, (6) add the two partials, (7) make molecular equation if desirable. O. C.

The High-School Attack upon the Problem of Study. See this title on page 385.

Teacher Training in the Use of Visual Aids. See this title on page 385.

ADMINISTRATIVE PROBLEMS AND DEVICES; CURRICULA

Progress Report on the Development of Teaching Units in High-School Physics. A. W. HURD. *North Cent. Assoc. Quart.*, **5**, 257–93 (Sept., 1930).—This is the third report the subcommittee on physics has made to the North Central Association. The committee organized the physics course into nineteen teaching units. Six units have been previously reported. Knowledge, technic, and appreciation objectives are stated for each unit as well as a list of ultimate objectives. Suggested supplementary activities for capable pupils and reference books for each unit are listed. Data secured from the teaching of twelve units in one or more coöperating schools during 1928–29 are included. C. M. P.

An Experiment in Correspondence Study. See this title on page 385.

The Carnegie Corporation List of Books for College Libraries. W. W. BISHOP. *Assoc. Am. Coll. Bull.*, **16**, 362 (Nov., 1930).—The preliminary list is limited to those colleges which applied to the Carnegie Corporation for aid in the purchase of books for their libraries; but it is proposed to publish through the American Library Association, 520 Michigan Ave., Chicago, the final edition of the list which will be available the first of February. The list is issued in twenty-four chapters covering the ordinary departments of instruction in colleges, with a general list of some length. The list has been prepared by 175 experts with the assistance of some twenty-five or thirty librarians. It will be useful as a means of checking the holdings of a college library and a basis for ordering new books. There will be a nominal charge. G. O.

KEEPING UP WITH CHEMISTRY

Must Develop Safe Refrigerants. ANON. *Hygeia*, **8**, 835 (Sept., 1930).—Mechanical refrigeration is not safe to the public unless it is free from poisonous elements. "When in 1929, ten persons died and nineteen were ill in Chicago as a result of leakage from systems using methyl chloride, the recommendation was widely made that sulfur dioxide or ammonia be used as a refrigerant because of their warning properties." As a result of such catastrophes various cities and states have undertaken legislation on refrigerants, but this hampers the manufacturer, and therefore increases the cost to the consumer. Consequently, the Committee on Poisonous Gases of the American Medical Association suggests that the legislation must be uniform and coördinated under the direction of such an agency as the U. S. Public Health Service. H. T. B.

X-Rays. EDIT. *Gen. Elec. Rev.*, **33**, 597–9 (Nov., 1930).—Throughout the ages man has used the word "light" as synonymous with knowledge and understanding. To early man light meant those vibrations which caused a reaction in his eye. Modern man conceives of an entire scale of vibrations of which visible light is but a small part. X-rays, those extremely short pulsations, have been of utmost value in opening the door to the knowledge of structure of matter. The X-ray has given us "light"; it has given us a new science of crystal structure and radioactivity, made certain the existence of molecules and atoms, shown the arrangement of atoms in a crystal, proved the electrical nature of matter, led to the quantum theory, and introduced a new conception of the universe. H. T. B.

The Largest American-Made Telescope Mirror. ANON. *Sci. Am.*, **143**, 274–5 (Oct., 1930).—The article describes a real chemical feat in glass-making. It describes the making of a two-ton optical disc 71 inches in diameter and 12.5 inches thick. The glass was cooled very slowly from its originally molten state and has undergone a slow process of grinding in order to make a perfect mirror. The disc is described as being physically and optically perfect. Illustrated. C. M. P.

Alcohol as a Fuel for Automobiles. P. W. UHLMANN. *Chem.-Ztg.*, **54**, 818–9 (Oct. 22, 1930).—The article is a report of an investigation carried out by the author in

Brazil in 1916. Ordinary 96% alcohol was dehydrated with freshly prepared quicklime followed by calcium carbide. Any traces of calcium salts were removed by distillation. The product obtained, which was 99.8% pure, was used as the raw product. It was mixed with ether and gasoline in the following proportions:

Alcohol, absolute	75 kg. (7100 cal.)	= 5325 cal.
Ether	15 kg. (9000 cal.)	= 1350 cal.
Gasoline	10 kg. (11,000 cal.)	= 1100 cal.
	1 kg. Fuel	= 775 cal.

This fuel has a specific gravity of 0.785 while that of the gasoline was 0.72. It showed up very favorably in actual tests. The research work of the author was interrupted by the war but is taken up again. Uhlmann is going to study the possibilities of using higher alcohols, particularly amyl alcohol which has a heat of combustion of nearly 9000 cal. L. S.

Reference Fuels Used as Anti-Knock Standards. *Syn. Org. Chem.*, **4**, No. 2 (1930).—Brief discussion of standard methods of evaluating the anti-knock value of gasoline engine fuels. H. H. K.

Perfume. M. MEYER. *Sci. Am.*, **143**, 118–9 (Aug., 1930).—The sense of smell is one of the senses in which animals are definitely superior to man. Man has lost his keen sense of smell. The author discusses perfumes as to essential ingredients, methods of making, chemistry involved, natural and chemically made odors, and methods of adulteration. C. M. P.

New Steel Alloy Is Rustproof. A. P. ARMAGNAC. *Pop. Sci. Mo.*, **117**, 31 (Dec., 1930).—Chromium-nickel steel is a new alloy which possesses properties all its own, among them being the ability to defy red rust. It goes under the names "Allegheny metal," or "Nirosta steel," and can be used in the home or in industry where a white metal is desired. It is unaffected by magnets and can be used in the instrument boards in airplanes. H. T. B.

Another Porphyry Copper in the Making. G. J. YOUNG. *Eng. Mining J.*, **130**, 522–4 (1930).—A description of the deposit and method of handling is given. A 50-ton experimental mill was used for treatment of the ore, which consisted in concentration by flotation, roasting and leaching the concentrate, and recovery of the copper by electrolysis. The roasting was carried out in three stages, the first at 500–700° F., at which a part of the sulfur is driven off, the second or sulfating stage for $1^1/_4$ hr. at 980°F., and the third stage of $2^1/_4$ hr. at 1100°F., during which any $FeSO_4$ formed during the first two stages is decomposed into the nearly insoluble oxide. H_2SO_4 was used in the leaching process which gave solutions containing 60 g. of copper and only 4–7 g. of iron per liter. Deposition of the copper was carried out in three steps, two series of electrolytic cells (lead anodes and copper cathodes) by means of which the copper content was reduced to 5 g. per liter. This was removed by passing through a trough containing detinned scrap. The water-soluble copper formed during the roasting supplies more than enough new acid so that no acid is used for maintaining the acid content of the solvent. The product obtained was of especially high grade. The economics of the process has not yet been studied. G. W. S.

The Reviving Liquid-Metal Industry. J. K. NOVINS. *Sci. Am.*, **143**, 298–300 (Oct., 1930).—Formerly we imported most of our mercury, but recently old mercury mines have been re-opened in Nevada and California. The United States uses about two and a quarter million pounds of mercury annually. The Phoenicians obtained mercury twenty-seven centuries ago from the famous Almaden mine in Spain, a mine which still produces one-half of the world's supply. The process of mercury refining and purification is interestingly described. Illustrated. C. M. P.

Mercury. See **The Reviving Liquid-Metal Industry** directly above.

The Bacteriological Chemistry of the Heavy Metals. E. A. COOPER AND S. D. NICHOLAS. *Chem. & Ind.*, **49**, 386T–8T (Sept. 26, 1930).—"Cadmium salts are actively germicidal, being much more potent than lead salts, but less so than mercury compounds." The experiments which have led to this conclusion are discussed. E. R. W.

Water Softening: Some Properties of Certain Base-Exchange Materials. Part 1. A. R. MARTIN. *Chem. & Ind.*, **49**, 389T–94T (Oct. 3, 1930).—A study of the two main types of base-exchange materials used for water softening, synthetic sodium aluminum silicates, and natural occurring minerals. A simple experimental procedure for these studies is described. E. R. W.

The Action of Chlorine on Coal. Part 2. A. ECCLES AND A. MCCULLOCH. *Chem. & Ind.*, **49**, 377T–82T (Sept. 19, 1930); 383T–6T (Sept. 26, 1930).—This study has been carried out with a view to elucidating the chemical constitution of coal. Apparatus

and results are described. Coal seems to combine with chlorine through substitution and addition reactions as well as because of its true "unsaturatedness." E. R. W.

Basic Intermediates for Dyestuffs: No. 38. Anthraquinine Halogen Derivatives and the Dianthraquinonylamines. Part 1. *Chem. Age, Dyestuffs Mo. Suppl.*, **23,** 27–8 (Oct. 11, 1930). E. R. W.

SCIENTIFIC REVIEWS AND BIBLIOGRAPHIES

Recent Ideas in Atomic Structure. K. A. BUXTON. *Rep. New Eng. Assoc. Chem. Teachers*, **32,** 56–60 (Nov., 1930).—An excellent summary of ideas in atomic structure from those of Dalton in 1808 to those of Rutherford and Bohr. As regards the relationship of the Rutherford-Bohr theory of the atom to chemical structure and its relationship to the periodic table, one is referred to the very full discussion given in "The Electronic Theory of Valency" by N. O. Sidgwick, published by the Oxford University Press, American Branch, New York City. O. C.

Diffusion, Osmosis, and Osmotic Pressure. W. C. HAWTHORNE. *Sci. Mo.*, 535–42 (Dec., 1930).—A very clear discussion of osmosis and osmotic pressure from the standpoint of the kinetic theory and the gas laws. Numerous experiments are described to illustrate the nature of osmosis. G. W. S.

The Synthetic Activities of the Cell. H. S. RAPER. *Chem. News*, **141,** 209–15, 225–31 (Oct. 3, 1930).—This is the presidential address of Professor Raper. It gives an interesting resumé of the syntheses of definite chemical products which occur in the cell. He illustrates with adrenalin and thyroxin, and then discusses the processes of alcohol fermentation, the fate of glycogen in the body and protein synthesis, and ends with the following conclusion:

"Classical organic chemistry with all its achievements of synthesis cannot yet claim to rival the synthetic activities of the cell. That it will ever do so as regards the synthesis of our main foodstuffs, the proteins, carbohydrates, and fats, cannot be foreseen. Both from the chemical and economic points of view the signs at present are not very hopeful. The synthetic breakfast table is a myth and likely to remain one. Man has, so far, not learnt from nature the mechanisms of synthesis that she uses and on which his existence depends, so that the tilling of the soil and reaping of the harvest must for long remain his most vitally important occupation." F. B. D.

Insulin. *Nature*, **126,** 810–2 (Nov. 22, 1930).—A resumé of the recent work on insulin, giving an account of its preparation and physiological action and indicating in addition some of the possible lines of investigation whereby the mechanism of the action of insulin can be studied. F. B. D.

Formation and Properties of Boiler Scale. E. P. PARTRIDGE. *Chem. Age*, **23,** 248–9 (Sept. 20, 1930); 306–7 (Oct. 4, 1930); 351–2 (Oct. 18, 1930).—Extracts from *Engineering Research Bulletin*, No. 15, published by the Department of Engineering Research of the University of Michigan in June, 1930. A very comprehensive treatment of the problems relating to boiler scale. E. R. W.

The Mechanism of Charcoal Activation. M. E. BARKER. *Chem. Warfare*, **16,** 815–29 (Oct., 1930).—During activation the hydrogen and oxygen content of charcoal is decreased, the density is increased by about one-half of the original density, and the charcoal acquires a crystalline structure as shown by X-ray studies. Activation increases the interior surface area by the production of a large volume of small capillaries. A selected bibliography of over thirty references is included. E. R. W.

HISTORICAL AND BIOGRAPHICAL

Albert Einstein. (*1*) "Albert Einstein, A Biographical Portrait," ANTON REISER, published by Albert & Charles Boni, New York City, **1930,** 225 pages, price $2.50; (*2*) "What I Believe," A. EINSTEIN, *Forum*, **84,** 193–4 (Oct., 1930).

Walter Herz. J. MEYER. *Chem.-Ztg.*, **54,** 773–4 (Oct. 4, 1930).—Walter Herz was born in Breslau on July 24, 1875, where he attended a high school and the university. His father was a physician. His doctor's thesis (1897), directed by Albert Ladenburg, dealt with a subject in organic chemistry. In 1900 he began teaching at the university of Breslau. In 1903 he was appointed first assistant to Ladenburg and in 1907 he became professor. Twelve years later he was appointed director of the department of physical chemistry.

Dr. Herz has done research work in the fields of organic, inorganic, and physical chemistry. He was a very industrious worker. First he studied the benzylimides of malic acid, condensed rings with para linkage, derivatives of piperazine, and partial racemy. Due to Ladenburg he became interested in this field. Under the influence of F. W. Küster and R. Abegg he turned to inorganic and physical-chemical problems.

For thirty years he studied the solubility of insoluble salts, liquids, and liquid mixtures. He worked on the equilibrium between ammonia and salts and between insoluble sulfates and alkali carbonates; he studied the distribution law. His results on the bromination and iodation velocity of organic compounds and the internal friction and fluidity of pure and mixed organic liquids and salt solutions, as well as his work on critical states is very interesting. During the last years of his life it became difficult for him to work in the laboratory on account of his eyesight. From then on he had to limit himself to theoretical studies which dealt with molecular weights, molecular diameters, thermic properties, specific properties, boiling points, critical properties, heat expansion, the Tront-Nernst constant, etc.

His most outstanding publication is his "Leitfaden der theoretischen Chemie." This book has appeared in four editions. Together with R. Abegg he wrote "Chemisches Praktikum" and with J. Gadamer he wrote "Chemische Toxikologie." He is the author of the chapters on boron and bismuth in the "Handbuch der anorganischen Chemie" by Abegg-Auerbach. For many years he published the yearly reports on physical chemistry in the *Chemiker-Zeitung*.

Dr. Herz was an outstanding scholar and a good teacher. He died from a cold on September 7, 1930. L. S.

Ludwig Moser. R. STREBINGER. *Chem.-Ztg.*, **54,** 849 (Nov. 1, 1930).—Dr. Ludwig Moser, director of the department of analytical chemistry at the Polytechnic Institute of Vienna died on September 26, 1930, as the victim of an automobile accident. He was born in Vienna in 1879. He studied chemistry at the Polytechnic Institute of Vienna where he obtained his doctor's degree. After having worked in the industrial field for a short time he was appointed an assistant at the Institute. He rose rapidly in rank. In 1920 he became director. Soon after that he founded a micro-chemical department. He published ninety-three articles on various subjects. His investigations on bismuth compounds are summarized in his book "Die Bestimmungsmethoden des Bismuth." His second book was entitled "Die Reindarstellung von Gasen." During the last few years he had been working on a large textbook of analytical chemistry which is only half completed.

Due to his wide experience he was called to court quite often as an expert witness. He was always in contact with industry and the patent office. Dr. Moser was president of the *Verein Österreichischer Chemiker* and honorary member of the Society of Public Analysts and Other Analytical Chemists. L. S.

An Appreciation of the Life and Work of Prof. W. H. Perkin. W. N. HAWORTH. *Chem. & Ind.*, **49,** 886–9 (Oct. 24, 1930). See also *Chem. Age*, **23,** 374–5 (Oct. 25, 1930).—An oration delivered before the Chemical Society on the occasion of the unveiling of the Perkin Memorial Plaque on Oct. 16, 1930. E. R. W.

From the History of Stereochemistry. In Memory of J. A. Le Bel. E. WEDEKIND. *Z. angew. Chem.*, **43,** 985–6 (Nov. 8, 1930).—Achille Le Bel, a member of the French Academy of Sciences died in Paris, at the age of 83, on August 6, 1930. He was born at Pechelbron, Alsace, in 1847. After the completion of his college education he devoted his time to technical studies of petroleum. Later he turned completely to purely scientific investigations.

Many people are under the impression that Le Bel was a co-worker of van't Hoff with regard to the van't Hoff-Le Bel theory. However, both investigators worked independently. In September, 1874, a booklet appeared by J. van't Hoff entitled "Voorstell tot nitbreidung der structuur-formules in der ruimte." A month later J. A. Le Bel published an article in the *Bulletins de la Société Chimique* under the title "Sur les Relations, qui Existent entre les Formules Atomiques et le Pouvoir Rotatoire de leur Dissolutions." Their ideas were not quite identical. Le Bel's theories were based on Pasteur's discovery of the relationship between crystallographic enantiormorphism and molecular asymmetry. By combining Pasteur's principle with the discoveries of modern chemistry of his days he discovered a simple means of predicting the rotation from formulas. Van't Hoff, on the other hand, built his theory on the asymmetric carbon atom and the regular tetrahedral structure. Le Bel contested already then that the asymmetric carbon atom was necessary and he regarded the regular tetrahedron only as the simplest solution of the problem. Le Bel furthermore applied his ideas to other elements and attempted to prove the occurrence of optical activity in organic ammonium salts in which four different radicals are joined to nitrogen. He worked particularly on isobutyl-propyl-ethyl-methyl ammonium chloride.

Le Bel was one of the few remaining scientists of the youngest classical epoch of French chemistry, an epoch the importance of which is characterized by such names as Berthelot, Moissan, Bouveault, and Mme. Curie. His name will be remembered

in the history of chemistry in relation to the fundamentals of stereochemistry and the theory of the asymmetric carbon atom. L. S.

The Reviving Liquid-Metal Industry. See this title on page 382.

EDUCATIONAL MEASUREMENTS AND DATA

The High-School Attack upon the Problem of Study. G. C. LOOFBOUROW. *Calif. Quart. Sec. Educ.*, **6**, 50–62 (Oct., 1930).—This is the resumé of a study carried out in seventeen high schools of the San Francisco Bay region. Usable information was obtained from 12 principals and 482 teachers. Administrative procedure and suggestions made to teachers by the 12 principals are included. Responses of the 482 teachers as to the specific devices used by them to help pupils study are tabulated according to frequency under subject headings. The four major tendencies stated in order of frequency are: (1) mechanics of study or classroom procedure; (2) organization and analysis of material; (3) method of making or taking the assignment, (4) the ability to read effectively. Psychological validation of the practices was attempted by the author by constructing a composite of the rules for study advanced by five leading authorities. A list of these rules is included. C. M. P.

Can Attitudes Be Measured? A. C. ROSANDER. *Phi Delta Kappan*, **13**, 75–9 (Oct., 1930).—Curriculum committees are very generally in the habit of listing attitudes, appreciation, and ideals in the objectives for courses in different subjects. If such objectives are desirable, means for ascertaining whether such objectives are attained are almost indispensable. Various attempts to measure attitudes have been made. Several such scales are described in brief.

The conclusion of the paper is "that attitudes can be measured with a fair degree of accuracy. Both individual and group attitudes can be measured and compared." There is still much to be done upon such scales before the measurement of attitudes is soundly established. A twenty-four title bibliography follows the paper. B. C. H.

The Influence of Attitude upon Transfer. M. F. DORSEY AND L. T. HOPKINS. *J. Educ. Psychol.*, **21**, 410–7 (Sept., 1930).—This is a report of the results of an experiment to determine the variations in the amount of transfer depending upon readiness to act as built up by suggestion given at the time of performance. The experiment consisted of three cases in which the equivalent-groups method was employed. To each group was furnished an identical situation to which it was possible to transfer elements of previous experience. To the experimental group was given the suggestion that such experiences might be used in meeting new situations, whereas no such suggestions were given to the control group. Identical tests were given to each group. Case I consisted of 28 college freshmen who had failed in the first quarter and who were given special instruction in how to study for the second quarter. The factor to be transferred was *method of study* to the study of a particular kind of material. Case II was made up of 20 freshmen girls who were taking first-year college Latin based upon four years of study of this subject in secondary school. The factor to be transferred was knowledge of Latin to an allied field containing new and old material. Case III included 100 freshmen engineers who had completed the study of descriptive geometry. The factor to be transferred was skill in manipulation of ideas from the situation in which it was learned to a new one outside of the field. Total scores, mean scores, and per cent of one group overlapping the mean of the other indicated marked superiority of the experimental group. Standard deviations indicated that greater individual differences occurred in the experimental group in Cases I and II, whereas the reverse was true in Case III. C. M. P.

Concerning College Grades. R. BYRNES. *Sch. & Soc.*, **31**, 684–6 (May 17, 1930).—A study, extending over a period of eight semesters, of the grades of undergraduate students at the University of Wisconsin, revealed that the scholastic average of women students is higher than that of men; that students who are members of sororities or fraternities rank above those not affiliated; and that members of professional sororities or fraternities rank distinctly above members of purely social organizations. K. S. H.

An Experiment in Correspondence Study. E. T. PLATT. *Neb. Educ. J.*, **10**, 380–3 (Sept., 1930).—There are many two-teacher high schools. Such schools have a very restricted curriculum to offer their students, many providing no elective subjects at all. The principal objective of the study in this paper was to find a means of enriching such a small high school's curriculum. The courses tried in the experiment were the history of English literature and second-year Latin. The author considers such a procedure entirely feasible for enriching small school curricula, and for providing additional work for the superior student in any school. B. C. H.

Teacher Training in the Use of Visual Aids. L. P. MILLER. *Educ. Screen*, **9**, 234 (Oct., 1930).—After observation of the use of different types of visual aids the author has his classes consider: values and outcomes of visual aids, types of visual aids, and sources of materials for visual aids. Selected references are cited under each topic. B. C. H.

An Analysis of Pupil Ratings of High-School Teachers. C. W. BOARDMAN. *Educ. Admin. Superv.*, **16**, 440–6 (Sept., 1930).—A statistical study of the correlation between pupils' and supervisors' judgments of teaching ability. Pupils ranked the teacher under five questions given to them as criteria, (1) work done for the teacher, (2) liking for teacher, (3) discipline, (4) amount learned, (5) teaching efficiency. A ranking of the teachers was likewise secured from supervisors and associates.

Four tables of correlations are presented.

Pupils' liking for teachers stands out as the biggest factor in their judgment of efficiency.

Pupils do not think the teachers they work hardest for are best—this is the lowest correlation.

Further studies of pupil and supervisor ratings of teachers are needed. G. W. H.

The Prediction of Teaching Success. R. R. ULLMAN. *Educ. Admin. Superv.*, **16**, 598–608 (Nov., 1930).—A statistical study of the relationship between personal qualifications as studied during preparation, and success in teaching in junior and senior high schools. One hundred and sixteen university graduates yielded the data. Twelve types of tests and data were used, all as objective as possible.

Some conclusions are: quite accurate prediction of teaching success can be made; success in practice teaching is the best single measure of success in teaching.

Tables are given. G. W. H.

Progress in Junior High-School Education, 1929-1930. C. O. MATHEWS. *Educ. Admin. Superv.*, **16**, 561–74 (Nov., 1930).—Some of the trends in junior high-school education as gathered from more than forty articles and books. The following lines of progress are treated: types of organization, problems of articulation, the curriculum, teaching procedures, training of teachers, counseling, and guidance.

The junior high school is not a unanimously accepted unit in American education. There is a tendency to group together subjects which formerly were separate. Nearly every state has neglected the adequate training of teachers. Guidance is receiving greater attention. An extensive bibliography is presented. G. W. H.

Research Projects on the Secondary-School Level Carried On in California Cities during 1929-30. F. C. FOUTON. *Calif. Quart. Sec. Educ.*, **6**, 5–38 (Oct., 1930).—The report summarizes the research activities carried out in twenty-two California cities. Data concerning each research study reported include: title; author; where carried out; nature of study and findings. C. M. P.

"Intensity" and "Amount" of Chemical Research Activity in the World. See this title on page 389.

THE PHILOSOPHY OF EDUCATION

Changing Conceptions of College Teaching. H. L. DONOVAN. *Educ. Admin. Superv.*, **16**, 401–10 (Sept., 1930).—The author reviews practices in the Medieval European universities and tells how these procedures have been passed on and clung to the colleges of today. The lecture method with its evils was the big inheritance. The advent of science into the college curriculum along with the rising importance of the library are two powerful factors making for change.

Some of the attempts to improve instruction in the colleges are mentioned and discussed. Under the head of "administrative devices" there are the survey, ability grouping, conferences between teacher and student, limited supervision of instruction, visiting specialists on college teaching, the experimental college, and honor courses.

Under the head of "faculty efforts" there are reorganization of curricula by professors, experiment with various types of teaching, the development of the rating scale, such as the Purdue Rating Scale and the Rating Scale for Teachers by Adams and Russel of the University of Kentucky, improvement of examination, and productive research by the teacher.

The writer believes that the best method of instruction involves the optimum of student participation.

There is a bibliography. G. W. H.

Liberalized versus Professionalized Subject Matter. How Can the Arts Colleges Supply Both? O. H. WILLIAMS. *Educ. Admin. Superv.*, **16**, 581–90 (Nov., 1930).—A discussion of the meaning, function, and plan of subject-matter courses and method courses and the values of proper integration of the two. There is a short history of the

development of each type of course. Though the idea of professionalization of subject matter is far from having universal acceptance the need and tendency will grow and it is in the liberal arts college that the crucial test will be met. It is the treatment, the attitude of the learner, which determines whether a course is liberal or vocational—any subject may be either. Methods of professionalizing several subjects, English and mathematics, are presented as the kind of procedure for other liberal arts college courses. G. W. H.

Some Observations on Academic Tree Sitting. W. M. LEWIS. *Assoc. Am. Coll. Bull.*, **16**, 322–30 (Nov., 1930).—The summer through which we have just passed has been productive of tree sitters. Thus the president of Lafayette College looks upon those who would clamber up the tree of knowledge and sit there for four years when as a reward for their aimless endurance the institution will bestow upon them a diploma. Academic tree sitting he believes is partly due to the aimlessness of the colleges themselves; to the reserving of the best instructors for upper classmen; to the fact that the colleges have such a "dead-level grading system." He also contends that scholastic accomplishment when used alone for college entrance requirements does not eliminate the academic tree sitters, basing his convictions on a survey made some five or six years ago by a committee of the Pennsylvania State Education Association in which they found that just about 50% of the girls and boys intending to go to college were good risks. He suggests as a possible remedy that the colleges not only examine the fifteen credits from the high school but the honest opinions of those teachers who have known the student over a period of years and his life history at least six years before he applies for college admission. G. O.

The Liberal Arts. A. H. UPHAM. *Assoc. Am. Coll. Bull.*, **16**, 331–9 (Nov., 1930).—The president of Miami University interprets the term "liberal arts" and asks the question, "Are subjects of study liberal, or do they become so as a particular generation finds them vital?" G. O.

The Liberal College and Human Values. R. L. KELLY. *Assoc. Am. Coll. Bull.*, **16**, 340–6 (Nov., 1930).—"Whatsoever things are true in science and philosophy and religion; whatseover things are good in human relationship, in things domestic, ethical, civic, social without discrimination as to sex or race or nationality or time or place of habitation; whatsoever things are beautiful in God's creation and in human character, the joint product of God and man, and whatsoever things have been made beautiful by the rare gift of man's artistic touch"—these are the elements upon which the American liberal college would build a new civilization. G. O.

How May the Balance of Educational Opportunity Be Maintained between Men and Women in the Coeducational College of Liberal Arts and Sciences. I. T. MEYERS. *Assoc. Am. Coll. Bull.*, **16**, 350–8 (Nov., 1930).—The coeducational colleges have not ignored their women students, but they have failed to recognize a difference in the applications which women make of their studies. Courses in colleges are usually offered by men, who were themselves taught by men, and who look into a world of men unconscious sometimes that women must enter it. It would seem that a coeducational institution could use contributions that come in from the standpoint of both man and of woman. Why should not a study of home finances be made equally as valuable for men and women in a department of economics as a study of money and banking? The solution to this problem of balance seems to lie in an organization of subjects into courses of study with definite and significant aims; by paying more attention to individuals, in recognizing the complementary character of the experiences of men and women. G. O.

Education and the Best of All Possible Worlds. G. WATSON. *Educ. Admin. Superv.*, **16**, 411–21 (Sept., 1930).—A thought-provoking discussion of the relation of school education to society. Some valuable information for those interested in the questions of education as a means for only passing on the heritage of the past or also as a means for effecting changes in the social order.

In support of the belief in education as an agent for the latter rôle some distressing symptoms of social disorder are treated with the presentation of authoritative factual material. There is the unequal distribution of income, industrial conflicts, fear of freedom of speech, propaganda, racial inequality, wars and organized killing, the imperialistic program, crime as a commonplace, waste, unemployment, birth control traditions, the immigration policy and disease.

Bulletins of various information services have been used as a basis for the article. G. W. H.

Inaugural Address of the President of the University of Chicago. R. M. HUTCHINS. *Sch. & Soc.*, **30**, 755–61 (Dec. 7, 1929); *Cf.* J. CHEM. EDUC., **7**, 1201 (May, 1930).—

Briefly spanning the past and setting forth the many advantages which have been Chicago's from the beginning, Dr. Hutchins tells how the ideals established with the founding of the institution are continually striven for and gradually being accomplished. Here, new ideas are tried out, new ventures undertaken, pioneering encouraged, and investigations carried on without interference. Students are encouraged to carry on free and unrestricted work in the field in which they are primarily interested and are stimulated to absorb as much of other branches of knowledge as they are capable of or choose to do. Chicago's influence on education has been tremendous, but most eminent of its fields is that of research.

Two problems which this institution considers its obligations are, first, to educate and train students in the field of research, and second, to find the best method of training teachers. Few Ph.D.'s become research workers, the majority drifting into the teaching field, where unfortunately creative productivity seems to end. Hence, it is suggested that the Ph.D. degree continue as a degree for college teachers—a different degree being conferred upon the research worker.

"It is men . . . that make education," and if the above program is to be carried out, salaries must be offered and available which will attract to the field of education men capable of carrying out experiments. K. S. H.

Colleges: For What Purposes? D. SNEDDEN. *J. Higher Educ.*, **1**, 365–72 (Oct., 1930).—A discussion of: (1) problems in differentiating liberal from vocational education, and (2) the place of liberal education in vocational training. H. H. K.

Continuing Education for the College Graduate. W. B. SHAW. *Bull. Am. Assoc. Univ. Profs.*, **16**, 474–6 (Oct., 1930).—A brief descriptive enumeration of efforts under way by a number of colleges to help their alumni, "to continue their college experience for its own sake." B. C. H.

PROFESSIONAL

How to Know Good Teachers. M. E. DEUTSCH. *Sch. & Soc.*, **31**, 525–8 (Apr. 19, 1930).—Discarding the two most universally accepted methods of selecting good teachers—first, the questionnaire, the disadvantages of which are emphasized by the author, and second, the number and kind of degrees one may have, the possession of which guarantees nothing as to one's teaching ability—Dr. Deutsch suggests placing the decision with those qualified to judge, those who through their learning and knowledge know what constitutes good teaching and who likewise possess the rare power of determining whether those under consideration possess the desired qualities and knowledge.

To obtain those who will unerringly select the best, and more than this, recognize the excellent teachers on a staff, the efforts and adequate sums necessary must be willingly forthcoming. K. S. H.

Training for College Teaching. L. B. RICHARDSON. *J. Higher Educ.*, **1**, 425–35 (Nov., 1930).—An interesting article in which the author points to the lack of training for college teaching which recipients of the Ph.D. degree receive who enter that work. The author has opportunity to point out the defects of the present system of graduate study. H. H. K.

The Enrichment of Experience in the Development of the Teacher. J. C. TRACY. *J. Eng. Educ.*, **41**, 53–71 (Sept., 1930).—Parents of college students are interested not only in the training and teaching methods of professors, but also "What is he?" and "What type of influence will he have on my son during his impressionable age?" The ideal teacher must have more than a thorough academic training, which only experience can give him. "We inevitably reveal by what we say, by what we do, and by our attitude toward life, the quality of our thought material," and by the same token the nature of our experience. One may enrich his experience by cultivating a thorough appreciation of the importance of experience, seeking first those experiences in which he is interested, seeking experience for its own sake, and seeking a well-rounded experience. This may be accomplished by contact with men, volunteer civic service, travel, and recreation. H. T. B.

Research Professorships. E. SABIN-SMITH. *Bull. Am. Assoc. Univ. Profs.*, **16**, 459–60 (Oct., 1930).—Our age has still to discover "the incomparable value to society of fully matured and trained minds. . . . We have learned to prize energy of action above tempered wisdom of maturity, optimism above knowledge, eagerness above power to weigh values." Retirement at sixty-five is a stupid waste of scholarship. This waste should be stopped by endowment so that retirement does not mean for women, because of limited means, a return to "domestic occupations and the mild excitement of rearing nephews and nieces."

There are many who at sixty-five are vigorous minded and whose critical and

trained faculties are at the height of their fruitfulness. There is "no greater privilege for any campus than to be the chosen home of a scholar. As Emerson said, there are people from whom power goes forth whether they will or no just by their very presence. This in countless ways would be true of a resident research professor."

B. C. H.

Current Issues in Teacher Retirement. *Res. Bull. Nat. Educ. Assoc.*, **8**, 223–77 (Nov., 1930).—The *Research Bulletin* explains the general nature of the retirement system and how it works; the fundamental principles of teacher retirement; list of state and local retirement systems now in existence; present status of teacher retirement legislation; sources of information regarding teacher retirement; and a selected special bibliography. C. M. P.

The Prediction of Teaching Success. See this title on page 386.

An Analysis of Pupil Ratings of High-School Teachers. See this title on page 386.

CONTEMPORARY NEWS AND COMMENTS IN CHEMISTRY AND EDUCATION

"Intensity" and "Amount" of Chemical Research Activity in the World. I. W. D. HACKH. *Chem. Weekblad*, **27**, 576 (Oct. 11, 1930).—It may perhaps be of interest to examine the following table showing the "intensity" and the "amount" of chemical research activity in the world, as judged by the number of publications published. Column *B* shows the percentage of the total number of articles published as given by E. J. Crane of *Chemical Abstracts*, while Column *A* shows the number of chemical papers published per million inhabitants.

	A	*B*
	Intensity of Chemical Activity	*Amount*
Germany	125.4	26.9
Holland	87.0	2.09
Switzerland	75.2	1.06
Austria	53.8	1.65
Great Britain, Canada	71.3	13.5
United States	62.5	25.8
France	62.0	12.0
Sweden	61.5	1.27
Hungary	34.1	0.93
Finland	29.8	0.36
Denmark	25.1	0.30
Czechoslovakia	22.8	1.07
Italy	21.0	3.03
Japan	17.8	3.71
Norway	13.1	0.12
Latvia	11.1	0.07
Russia	10.4	3.4
Belgium	10.1	0.28
Poland	6.6	0.68
Chile	5.5	0.08
Argentine	4.7	0.16
Roumania	4.4	0.26
Spain	4.0	0.29
Brazil	0.6	0.06
China	0.13	0.17

These figures are accurate only in so far as the nationality of the authors could be identified. Thus many of the Belgian chemists who publish in a French periodical may have been credited to France, while a Norwegian writing in a German magazine may have been counted as German. Nevertheless, the figures are interesting in showing the distribution of chemical work. F. B. D.

Graduate Degrees, with Major Field in Education, Given during Academic Year 1929-30. F. C. FOUTON. *Calif. Quart. Sec. Educ.*, **6**, 39–49 (Oct., 1930).—The report includes a list of the doctor and master theses completed at the University of California, Claremont College, Occidental College, University of Southern California, and Leland Stanford Junior University. These theses are listed by title and author. C. M. P.

The Museum of Science and Industry. W. KAEMPFFERT. *Chem. Bull.*, **17**, 291–5 (Nov., 1930).—The Fine Arts Building of the World's Columbian Exposition of 1893 is to be recreated in Jackson Park, Chicago, and will house a museum of science

and industry. It is intended that people may have the opportunity of gratifying their interest in technology, and of surveying the technical and social progress of the past in order that they may evaluate the status of the present. The visitor may trace, if he chooses, the evolution of locomotives, the development of certain chemical processes, or of an entire science. Large numbers of working models will be installed so that one may observe actual operation. H. F. B.

Progress in Junior High School Education, 1929-1930. See this title on page 386.

The National Academy of Sciences. II. *Science*, **71**, 402–8 (Oct. 17, 1930).—A continuation of titles of papers read at the meeting held at the University of California from September 18th to 23rd. *Cf.* J. CHEM. EDUC., **8**, 177–8 (Jan., 1931). G. H. W.

Indiana University's New Chemistry Building. See page 392.

American Association for the Advancement of Science. See page 394.

Pernicious Anemia Cure Wins Popular Science Monthly Annual Award. See page 396.

Cancer-Causing Substances Flash Danger Signal. See page 397.

Announcement of Third International Congress on Bituminous Coal. See page 397.

Thirteenth Exposition of Chemical Industries, New York City. See page 398.

Second Annual Meeting of the Society of Rheology. See page 399.

Government Scientist Announces Final Value for Gravity Constant. See page 401.

Simple Chemical May Replace Liver as Anemia Cure. See page 402.

Mellon Institute Announces Industrial Fellowship on Sugar. See page 403.

National Advisory Committee on Education. See page 403.

Changes in Organization at the University of Chicago. See page 404.

European Study Tours for American Educators. See page 406.

Enrolment of Teachers in Summer Schools. See page 406.

South Dakota Education Association. See page 406.

Anniversary Meeting of the Royal Society. See page 407.

Lectures at Cooper Union. See page 407.

Dakota Wesleyan University. See page 407.

Hastings College Chemistry Club. See page 407.

Dr. Koch Lectures at De Paul University. See page 408.

Missouri School of Mines. See page 408.

Washington University. See page 409.

Department Activities at the College of the City of New York. See page 409.

Chemistry Research at the State University of Iowa. See page 409.

FOREIGN CHEMICAL AND EDUCATIONAL CONDITIONS

Soviet Children and Their Schools. S. HOODNITZKAYA. *Prog. Educ.*, **7**, 287–93 (Oct., 1930).—The author is research associate of the Pedagogical Institute for the Re-Training of Teachers, Moscow, U. S. S. R. The program of education of the Soviet Republic is closely connected with the five-year program of industrialization and reconstruction. The school is closely bound up with the community. Socially useful labor is the heart of Soviet education. The chief significance of this labor lies in the fact that the child is trained to apply immediately all the knowledge, skills, and attitude acquired at school. Knowledge gained is to be put to immediate use. Nature study is receiving major attention and special attention is paid to trips and excursions for collecting materials and facts. Soviet education is based on the concept of "the child and society." C. M. P.

A State Experiment in Chemical Research. G. T. MORGAN. *Science*, **71**, 379–90 (Oct. 17, 1930). *Cf.* J. CHEM. EDUC., **8**, 179 (Jan., 1931). G. H. W.

Research at Teddington, England. See **A State Experiment in Chemical Research** above.

GENERAL

How Long Can We Live? P. DE KRUIF. *Ladies' Home J.*, **47**, 3–5, 195–7 (Feb., 1930).—Human life has been lengthened tremendously on the average. Babies born in 1850 could expect to, on the average, live only thirty-five years. A baby born today can expect to live to be 55. Why? Because science has partly conquered the diseases of babyhood and adolescence. Science has not lengthened human life, for the chances of one's living to an old age are not much better today than they were in 1850. After discussing the various fads such as buttermilk, gland treatment, etc., advocated as a means of lengthening human life, the author comes to the conclusion that they have little, if any, scientific basis. He describes some of the recent biological experiments of Pearl, Loeb, and Slonaker with white rats and Drosophila melanogaster. The one best

guarantee of living a long life is to have long-lived ancestors. Heredity is the single, most important factor. Living out of doors with plenty of fresh air and sunshine and the proper diet will help. However, before the human race can expect a lengthened old age, such diseases as cancer, Bright's disease, and heart disease must be conquered by means of science. C. M. P.

The Color Camera's First Aerial Success. M. B. GROSVENOR. *Natl. Geog. Mag.*, **58**, 344–53 (Sept., 1930).—The author discusses aerial color photography, its difficulties, and probable great future. Eight aerial nature color plates are included. C. M. P.

The Conquest of Antarctic by Air. R. E. BYRD. *Natl. Geog. Mag.*, **58**, 127–227 (Aug., 1930).—This is the story of the Byrd Antarctic expedition as told by the leader himself. Science permeated practically every phase and activity of the expedition. Probably the most valuable of the many accomplishments are the contributions made to scientific knowledge. The article is splendidly illustrated. C. M. P.

How Diseases Have Ruled the World. J. STAFFORD. *Sci. News Letter*, **18**, 278–9 (Nov. 1, 1930).—A brief review of Dr. MacLaurin's explanation of various physical abnormalities and diseases of prominent historical characters and their effect upon the world's history. B. C. H.

Iodine in Paying Quantities Discovered in California. Iodine, expensive and pungent-smelling chemical, has been discovered in paying quantities in southern California. This comparatively rare chemical element has long been controlled by a South American monopoly which regularly maintained a "pegged" world price on the commodity at a high level. Industries concerned with an iodine supply during possible future war blockade are much interested in the local prospects.

Some time ago Los Angeles petroleum chemists, analyzing brackish waters from oil wells near Long Beach, California, discovered iodides in commercial quantity. So great is the mass of worthless salts associated with the iodine, however, that difficulty has been experienced in extraction of the desired product. At least one company, however, has attained some success with the problem, and California iodine is appearing on the market.

One of the favored methods of manufacture involves the treatment of the brine with nitrous acid which drives the iodine out of its salty compounds and permits it to be absorbed in activated charcoal much as war gases were caught in gas masks. Distillation of the loaded charcoal yields the precious product, which commands about four dollars per pound.

Iodine holds a queer economic position in chemical industry. To be sure, it goes into drugs, disinfectants, a few dyes, photographic supplies, and a host of minor applications. Apparently nobody uses it in huge quantities, though very many persons require small quantities of the substance. Accordingly nobody is seriously embarrassed if a monopoly charges several prices for the supply. The South American producers could furnish a very much larger quantity than that now marketed, but prefer to restrict trade and charge a high toll.

As yet the southern California production is not large enough seriously to threaten the monopoly, but with extension of oil-drilling operations it is hoped that the business of producing iodine may be brought down into the domain of the law of supply and demand.

Iodine has two inexpensive chemical brothers, chlorine and bromine, which have taken over most of the large-scale duties which manufacturers might well have assigned to the more expensive element. Iodine is a solid, rather than a fuming liquid like bromine or a corrosive gas like chlorine. There are accordingly many situations where chemical manufacturers would find it superior in technical use. As long as iodine is a hundred times as costly as free chlorine, and fifteen times as expensive as bromine, it can hardly make much industrial progress.—*Science Service*

Contemporary News in Chemistry and Education

INDIANA UNIVERSITY'S NEW CHEMISTRY BUILDING*

ROBERT E. LYONS, INDIANA UNIVERSITY, BLOOMINGTON, INDIANA

Indiana University takes its origin from the State Seminary which was established at Bloomington in 1820. Instruction in natural philosophy and chemistry was given at Indiana in 1829 by PROFESSOR J. H. HARVEY. A laboratory, one of the first west of the Allegheny Mountains, was provided in 1841, and the first full-time professor of chemistry at Indiana, Thomas C. Van Nüys, M.D., was appointed in 1874.

Wylie Hall, one of two original brick buildings on the present campus, has been the home of the department of chemistry from the date of erection, 1884. The growth of the department long ago exceeded the capacity and facilities which this building provided.

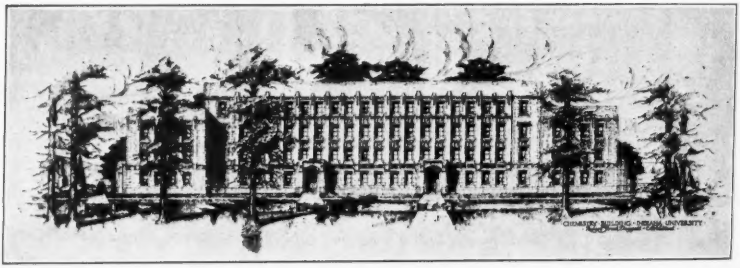
In the period 1886–1930, a total of 782 degrees have been granted in chemistry: A.B., 604; A.M., 157; Ph.D., 21. The number of students enrolled in chemistry in the year 1929–30 was 1959, including 26 chemistry majors in the graduate school.

It is with pardonable pride that the chemistry department will soon be able to move into commodious, modernly equipped quarters which will permit the renewal and further development of our program of expansion.

General Plans

The appearance of the north front of the structure, with two of the five entrances, is illustrated in the accompanying sketch and the general arrangement is shown in the cut* of the first-floor plan, which is typical of all floors.

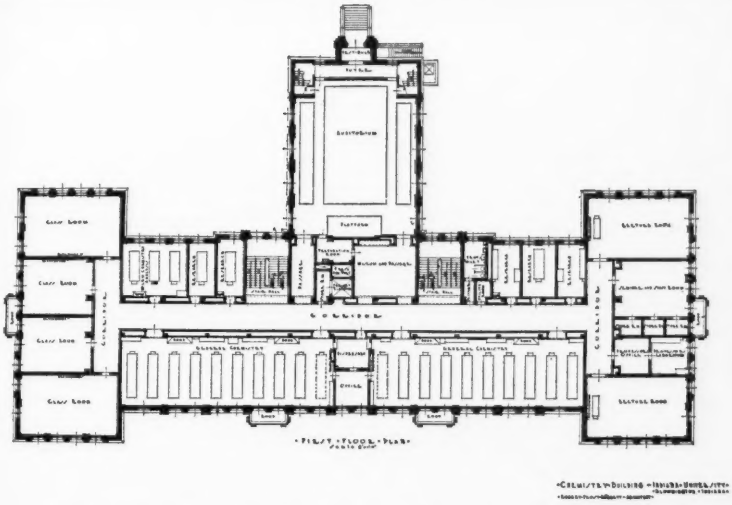
The building is constructed of concrete faced with buff Oolitic limestone and has the form of the letter E with a five and one-half foot service basement under the entire area. Machine room space for electric transformers, water heater, air compressor, etc., is provided in a sub-basement; equipment for the production and distribution of distilled water has been placed in the pent house. The roof construction is such that the openings from exhaust fans and the pent house are not visible from the ground level.



The central portion of the E, fronting north, is 192 feet long by 72 feet wide and four stories in height. The two-story auditorium projection to the south is 60 feet by 55 feet and the wings, the top and bottom of the E, each three stories, are 100 feet by 42 feet. By extending

* The formal opening and dedication will be held in Bloomington on April 2, 1931, in connection with the 81st meeting of the Division of Chemical Education of the A. C. S.

* Cuts by courtesy of architect, Robert Frost Daggett, Indianapolis.



these wings additional space may be provided in the future without changing the present installations.

The building, which has a total cubage of 1,255,154 cubic feet and a gross floor area aggregating 85,850 square feet, has been erected and provided with mechanical equipment for heating, ventilating, plumbing, electric power, light and elevator, inclusive of architects' and engineers' fees, for $505,918.00, or forty cents per cubic foot.

The laboratories for each of the major divisions of chemistry, general, analytical, physical, and organic, occupy the central portion of the building, have north light and are grouped about a central stockroom on each floor. The stockrooms, in turn, are connected by elevator with the main supply and receiving rooms on the ground floor. Special dispensing rooms and conference rooms are located between the two laboratories provided for general and also for organic chemistry.

Smaller laboratories are provided for advanced inorganic, industrial and biochemistry, gas, spectrum, polariscopic and micro analysis, catalysis, chemical microscopy, zymochemistry, conductivity, metallurgy, high-temperature furnaces, and electrochemistry, including storage batteries.

In addition twenty-three research rooms for graduate students are distributed throughout the building and each instructor has been provided with a laboratory and office. The departmental library adjoins the general office on the ground floor at the west entrance. Three lecture rooms, each with a seating capacity of one hundred ten, are provided in the west wing. The auditorium is equipped with 350 tablet-arm opera chairs on the main floor and 150 in the balcony. These rooms have wood floors laid on rock wool and have received special attention as to acoustical treatment, lighting, and projection equipment.

Provision has been made for a seminar and staff conference, or social purpose room on the first floor, a chemical museum at the entrance to the auditorium, a dark room, Kjeldahl room, shop, and vaults for storage of platinum ware and of alcohol.

Special Features

Laboratory Furniture. The desks are built of wood. Alberene stone tops are provided on those for general, qualitative,

quantitative, and organic chemistry. Master-keyed, changeable combination locks have been used on the desk drawers and cupboards. Both A. C. and D. C., 110-volt, and battery current have been provided on laboratory desks where required. Individual student panels carrying a switch, fuses, and binding posts are installed on those desks.

Plumbing. Duriron pipe has been used for all laboratory waste lines and the dilution tank. Ceramic sinks, lead traps, lead troughs, and buffed red metal plumbing fixtures have been used throughout. Block tin lines with burned joints and tinned cocks have been provided for distilled water distribution.

Hood Ventilation. Transite wall hoods of the open Cornell type have been used throughout, except in the qualitative laboratory, where Sheel downdraft table hoods are installed. The hoods are served by Duriron blade fans, located in the attic, through ducts equipped with adjustable, locking dampers to permit equalization of the pull. The vertical, inaccessible, fume hood ducts are constructed of Knight tile; other duct work is of copper-bearing steel, lead-plated and gilsonite-coated at the time of installation. The movement of all air in the building is toward the hoods, thereby reducing to a minimum diffusion from laboratories into the corridors.

Electrical Installation. The electric furnace laboratory is equipped with a transformer which will furnish current of 110 volts and 300 amperes in steps, each of about 20 volts, down to 25 volts at 2000 amperes. Direct current up to 300 amperes and 110 volts is also available for the electrolysis of fused salts and other work requiring it.

General Details. Metal sashes with two movable and adjustable sections permit cleaning the entire outer surface of the windows from within.

The floors in all laboratories are surfaced with acid-resisting mastic; the corridors and stairs with terrazzo.

All paints and lacquers used on the interior were previously tested as to resistance to laboratory gases.

The architectural beauty of the building is enhanced by a limited amount of carving in conventional design. Its dedication to chemistry has been emphasized by placing on the 46 ornamental shields, between the pilasters across the front, pairs of symbols of the known chemical elements in order of atomic number and selected alchemistic symbols on the shields on the wings and at the rear of the building.

Our effort has been to build and equip, within available resources, a fundamentally complete, durable and usable chemistry building.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

The $1000 award for 1931 of the American Association for the Advancement of Science went to M. A. TUVE, L. B. HAFFTAD, and C. DAHL of the Department of Terrestrial Magnetism, the Carnegie Institution, Washington, D. C., for their paper presented before the American Physical Society during the December 29th–30th meeting of the A. A. A. S. at Cleveland. The paper dealt with the measurement and artificial creation of radium rays in a 2,000,000-volt X-ray tube, which are more penetrating than any heretofore produced or measured.

The chemistry section of the meeting of the American Association for the Advancement of Science at Cleveland was sponsored by the Cleveland section of the American Chemical Society. It assembled on December 30th at the Morley Chemical Laboratory of Western Reserve University, and the following program was presented:

Mosaic Disease of Tobacco. Isolation of an Active Virus Fraction Very Low in Ash.—CARL F. VINSON

The Structure of Gels.—LEO FRIEDMAN

The Formation of Liesegang Rings in Gels.—OLIN F. TOWER

The Chemistry of Biologically Active Lipoids from Tubercle Bacilli.—R. J. ANDERSON

The Chemistry of Proteins in Liquid Ammonia. *Preliminary Report.*—E. W. MCCHESNEY

The Activation Energy of Adsorption and Catalytic Activity.—HUGH S. TAYLOR

Some Chemical Aspects of the Origin of Petroleum.—S. C. LIND

Significant Temperatures in the Pyrolysis of Certain Pentanes and Pentenes.—JAMES F. NORRIS AND GEORGE THOMSON

Boron Fluoride as a Reagent in Acetylene Catalysis.—J. A. NIEUWLAND

The Analysis of Breast Milk Fat.—P. E. ROLLER

The Chemistry of Humus Bodies Obtained from Protein Material of Certain Alaskan Peas.—S. L. JODIDI

Inorganic Iron Supplements in Nutritional Anemia.—H. H. BEARD and V. C. MYERS

Hydrolysis of Halogenated Aromatic Hydrocarbons in Aqueous Solutions.—EDGAR C. BRITTON

Science Service gives the following resumé of reports presented at the chemical and other sections of the Cleveland meeting:

The chemist now knows that such a complex mixture of hydrocarbons as occur in petroleum may be obtained through chemical reactions starting with a single, simple mother substance, DR. S. C. LIND, director of the school of chemistry of the University of Minnesota, told the American Association for the Advancement of Science.

Just how these reactions are brought about in nature is not yet known, but the fact that they can be accomplished in the laboratory indicates their possibility as natural processes. This is a step toward the solution of the great mystery of the origin of the oil in the crust of the earth, but it does not settle the question as to whether the processes of nature manufacture petroleum from a vegetable, animal, or inorganic source.

By application of heat and pressure, or by bombardment with the alpha rays from radioactive substances, it is possible to obtain from a single simple hydrocarbon a synthetic petroleum that is probably just as complex as petroleums occurring in nature.

"The simplicity of such a mechanism may lend indirect support to the old idea of an inorganic origin from one or a few hydrocarbon gases such as might be produced by the action of water on metallic carbides in the earth's interior," said Dr. Lind. "On the other hand, it does not preclude animal or vegetable origin, but strongly suggests that the primary material, whether gaseous, liquid, or solid, is later subjected to thermal or ionic agents or both which produce the complexity found in nature."

Chemicals Change Stretching Capacity of Protoplasm

Protoplasm, the jelly-like stuff that is the physical basis of life, can be stretched like rubber, if one employs the proper tools. At the meeting of the physiological section of the Botanical Society of America PROF. WILLIAM SEIFRIZ and JANET PLOWE of the University of Pennsylvania reported on tests conducted on this property of the life-stuff.

They took hold of bits of protoplasm with ultra-fine needles manipulated under the microsope, and stretched it as far as they could before it broke. Then they treated other cells with various chemicals, and tested the extensibility of the protoplasm after treatment. Some of the chemicals increased the stretchability, others diminished it. Salts of calcium and strontium increased the extensibility, magnesium salts did not affect it, and salts of potassium, lithium, and sodium diminished it.

Cuttings Take Root Faster When Fed Certain Chemicals

Certain chemicals greatly stimulate the rooting process of both hardwood and softwood cuttings, IRWIN KLEIN reported. Mr. Klein's experiments were conducted at The Ohio State University.

Common cane sugar, glucose, and potas-

sium permanganate proved the most powerful stimulants to the propagation of cuttings. After being soaked in solutions of these chemicals for 24 hours, cuttings showed an increase of between 72 and 402 per cent in the number of roots, as compared to untreated cuttings grown under the same conditions. The length of the roots was even more greatly increased by the chemical bath.

Cuttings soaked in sucrose, glucose, or potassium permanganate solutions sprouted roots which were from 96 to 648 per cent longer than untreated cuttings.

Liver Extract Makes Plants Green

Liver extract, successfully used to check the course of pernicious anemia in human beings, has been used to check the analogous yellowing of plants placed in the dark, by Prof. Oran Raber of Immaculata College, Pa. Prof. Raber reported this research before the American Society of Plant Physiologists.

The activity of liver extract in checking this yellowing, or etiolation, of darkened plants, raises again the question of the possible physiological relationship between chlorophyll, the substance that makes leaves green, and hemoglobin, the stuff that makes blood red. Liver extract keeps red blood in the veins of the anemic; it now appears to keep green chlorophyll in the leaves of plants.

Poison Found for Troublesome Bushes

A poison for undesired bushes such as poison ivy and European barberry, quick and sure in its action yet clearing out of the soil after its work is through, was also described before the meeting of the American Society of Plant Physiologists by PROF. R. B. HARVEY of the University of Minnesota. This new agent in man's chemical warfare against tough weeds is ethylene oxide, chemically related to the ethylene chloride which has been found very effective in hastening the ripening of fruits and vegetables. Professor Harvey found that the oxide killed the fruits and vegetables instead of speeding up their ripening processes.

He tried the compound on some large barberry bushes, which are being harried out of existence in the great grain areas because they harbor the black stem rust of wheat. What he calls "depth charges" of ethylene oxide dissolved in water were sunk into holes pierced in the soil at the roots. A few days later the bushes were revisited, and in every case they were found to be in the last stages of the death struggle. About one and one-half ounces of ethylene oxide, diluted out to a ten per cent solution in water, usually sufficed for a large bush.

At present barberry bushes are fought either by digging them up, which leaves stray roots free to sprout again, or by dumping quantities of common salt into holes at their roots, which is rather hard on the soil. Other chemicals which are effective against them cannot be used because they are poisonous to cattle. "Depth charges" of ethylene oxide, Professor Harvey concludes, seem to offer the best means so far discovered for killing these and similar noxious plants.

PERNICIOUS ANEMIA CURE WINS POPULAR SCIENCE MONTHLY AWARD

Popular Science Monthly has announced that the first bestowal of its annual award of $10,000 for the current achievement in science of greatest benefit to the public was made on December 18, 1930, to DR. GEORGE HOYT WHIPPLE, dean and professor of pathology of the School of Medicine and Dentistry in the University of Rochester, who discovered the principle of liver diet as a cure for pernicious anemia, and DR. GEORGE RICHARDS MINOT, professor of medicine in the Medical School of Harvard University, who perfected its application to human beings. $5000 and a gold medal each commemorating the award were presented to Dr. Whipple and Dr. Hoyt.

CANCER-CAUSING SUBSTANCES FLASH DANGER SIGNAL

A peculiar blue-violet fluorescence may provide a test for cancer-producing compounds. This new weapon in the investigation of artificial cancers is due to DR. W. V. MAYNEORD and I. HIEGER, two scientists at the Cancer Hospital Research Institute, London. They find that when substances known to cause cancer in mice are illuminated with a beam of ultra-violet light, a blue spectrum appears.

The existence of such substances was first discovered because the employees in the shale oil and coal-tar industries were found to be particularly susceptible to the disease. Later it appeared that cancer may be produced artificially by prolonged contact with many tar-like liquids obtained by heating common substances—for instance, skin, muscle, and hair—to the temperature at which iron begins to glow dull-red. The workers of this laboratory have recently shown that a similarly harmful substance may be obtained at low temperatures by the action of aluminum chloride on tetrahydro naphthalene—a commercial coal-tar product used in the dye industry.

It was this condensation product which has recently been found to give the blue fluorescence. A search is now being made for other compounds of known constitution which show the same property. This has been successful in that several compounds related to benzanthracene have been shown to give a similar spectrum and also to be cancer-producing. Benzanthracene is built up of four benzene rings cemented together. It is believed that substances in coal tar which predispose to cancer are similar in nature.

While not all cancer-producing substances show this spectrum and while some which do show the spectrum do not cause cancers, the new test is likely to be of assistance in uncovering the origin of cancers which develop spontaneously.—*Science Service*

ANNOUNCEMENT OF THIRD INTERNATIONAL CONGRESS ON BITUMINOUS COAL

The third international conference on bituminous coal will be held at the Carnegie Institute of Technology in November, 1931, according to a recent announcement made by DR. THOMAS S. BAKER, president of the Institute of Technology and organizer of the first two international congresses. An invitation will be extended to scientists of all countries to take part in the meeting, which is the only one of its kind of international scope. Prominent men of affairs in America will assist Dr. Baker in organizing the meeting.

The purpose of the congress, President Baker announced, will be similar to that of the meetings held in 1926 and 1928: to present for discussion the results of recent studies of coal. Particular attention will be paid to the economics of the new methods and processes that are being evolved, he indicated.

The program will include papers on carbonization, liquefaction, and gasification of coal; by-products of coal; the mechanism of combustions; cleaning of coal and its preparation for the market; pulverized fuels; power plants; and domestic heating. The discussions will be confined to coal above ground. Beginning at the mouth of the mine, however, practically every phase of distribution and consumption will be treated by outstanding authorities in the several fields.

"The condition of the coal industry during the past few years can hardly be called healthy," President Baker said, "and the current business let-down has brought extreme depression to this basic world industry. We hope that as a result of the discussions held we may be of assistance in uncovering new processes which may help it on the road to recovery."

Announcement of this third world meeting comes in logical sequence to the previous congresses. The first conference

was organized by President Baker in 1926 for the purpose of finding new uses for bituminous coal and especially to discuss the problem of liquefying coal to supplement the petroleum oil supply of the world. This meeting, although it was the first of its kind to be held, attracted 1700 scientists from thirteen different countries. Two years later followed the second congress which was broader in its scope, including discussions on pulverized fuel, low-temperature carbonization of coal, rubber from coal, the hydrogenation of coal, and by-product nitrogen. Speakers during the two conferences have been such scientists as GEORGES CLAUDE, DR. FRIEDRICH BERGIUS, PROF. FRANZ FISCHER, DR. C. H. LANDER, DR. R. LESSING, GENERAL GEORGES PATART, DR. FRITZ HOFMANN, and DR. KARL KRAUCH.

THIRTEENTH EXPOSITION OF CHEMICAL INDUSTRIES, NEW YORK CITY

During the week of May 4 to 9 inclusive, 1931, the Thirteenth Exposition of Chemical Industries will be held at the Grand Central Palace, New York.

It has already been announced that the Students Course upon the Fundamentals of Chemistry and Chemical Engineering will again be instituted under the chairmanship of PROFESSOR W. T. READ, dean of chemistry at Rutgers University, who is a member of the Exposition Advisory Committee.

The exposition will include three floors of exhibits devoted to the raw materials suitable for the manufacture of chemicals and chemical products, various other technical products used in the arts and industries, apparatus and equipment, machinery, and the finished products of the chemical industries.

The machinery and apparatus will vary from laboratory equipment, supplies, and instruments through instruments of precision for recording temperature, pressure, volume, flow, and the many other factors which are brought under control in industrial operations, through the apparatus and equipment in large-scale operations. In many cases whole processes will be shown in operation.

Special fundamental operations utilized in the chemical industries will be shown in the demonstrations, including disintegration, crushing, grinding, grading, mechanical separation, including filtration, classification, settling, thickening, evaporation, distillation, drying, weighing, measuring, mechanical handling of materials, conveying, and the demonstration of materials of construction. For the last named the chemical industries are constantly seeking materials for permanence to resist corrosion and destruction by the materials used in reactions conducted in the industries; and the products displayed will include ceramic materials, glassware, metals, alloys, plastics, wood, fibers, fabrics, and a long list of materials developed for many special purposes.

There will be special sections in the exposition devoted to the showing of the raw materials from our Southern States, a section for the natural resources of Canada and its various provinces, one for laboratory supplies and equipment, another for materials handling, and still another in which be will demonstrated the numerous types of containers suitable for various chemicals and chemical products.

Exhibits of New Metals and Alloys

Since the last exposition of chemical industries, long strides have been made in the commercialization and use of highly specialized alloys, and exhibits of this group at the Thirteenth Exposition are sure to command interest and close study.

The demands of the automobile called forth many alloys never before known and set metallurgists to working in many a laboratory with a zeal that has never since abated. Today a host of industries are demanding alloys capable of meeting their own peculiar requirements, and another host of manufacturers are busy meeting these demands.

From the bowels of the earth, where hard rock and corrosive, mineral-laden waters impose extreme conditions on mining machinery and tools, to the lonely spaces above the clouds where strength must be coupled with extreme lightness and resistance to corrosion, go the new alloys.

The high temperatures and pressures used in modern boilers require a steel that can keep its strength at temperatures that ordinary steels will not endure—a steel that not only will not burst, but that will not "creep" or stretch under prolonged strain at the temperatures common in oil and powdered coal-fired boilers; a steel, also, that will withstand the corrosive action of the gases of combustion at those high temperatures. The steam output of those boilers also must be handled by valves that will not warp and jam, or corrode. Alloys developed to meet these demands have six to eight times the strength at service temperatures of the low-carbon steel so long considered satisfactory for boiler duty.

The tendency of the railways to impose increasing wheel loads calls for rails of stronger steel—and the call is being met. In bridge work there is another great field for steels of high tensile strength and resistance to corrosion. In large bridges the dead load is so great that the live load sinks into comparative insignificance. If the elastic ration of bridge steel can be increased ten per cent, the dead load can be reduced twenty-five per cent. And if corrosion-resistant steel can be used, much of the cost of maintenance is eliminated.

In fields as diverse as the equipment for chemical plants and cooking utensils for kitchens, dental bridges and fillings, and jewelry, the new alloys have been making steady headway during the past two years. Mass production methods, necessary to any large-scale use, have been improved and costs cut. Methods of heat-treating and working have been developed or improved for alloys that defy the methods of working used on ordinary low carbon steel. Improvements in the use of the X-ray for examination of machine parts has facilitated detection of hidden defects. Consumers, long accustomed to the old metals and the old methods, have made progress in understanding the new alloys they must use henceforth. All of this is more or less indicated by the statement, made a few weeks ago by an officer of one of the great alloy steel manufacturers, that in the face of current business conditions, production of some of the high-priced alloys has increased from twenty to forty per cent over 1929.

SECOND ANNUAL MEETING OF THE SOCIETY OF RHEOLOGY

The second annual meeting of the Society of Rheology was held at Lafayette College, Easton, Pennsylvania, on December 29 and 30, 1930. The following program was presented:

Monday, December 29th

9:00 A.M. Registration, Gayley Chemical Laboratory, Lafayette College.

10:00 A.M. Address of Welcome, WILLIAM MATHER LEWIS, president of Lafayette College.

10:10 A.M. Response, WHEELER P. DAVEY, president of the Society of Rheology.

10:15 A.M. "Explicit Formulas for Slip and Fluidity," MELVIN MOONEY, U. S. Rubber Co.

10:45 A.M. "Solvation and Viscosity of Lyophilic Dispersions," ELMER O. KRAEMER and GEORGE R. SEARS, E. I. du Pont de Nemours and Company.

11:15 A.M. "The Kinematics of Slow, Stationary Flow of Rigid Bodies," Á. NÁDAI, research engineer, Westinghouse Electric and Manufacturing Company.

11:45 A.M "Preferred Orientation in Silver Foil Produced by Cold Rolling," CLEVELAND B. HOLLABAUGH and WHEELER P. DAVEY, Pennsylvania State College.

2:00 P.M. "Note on the Melting Point of Pitch by the Ball and Ring Method," FRED C. EATON, Easton, Penna.

2:15 P.M. "An International Comparison of Viscometers," S. ERK, research scientist, Physikalisch - Technische Reichsanstalt, Berlin, Germany.

2:45 P.M. "Slippage of a Non-Newtonian Liquid," MARKUS REINER, Department of Public Works, Jerusalem.

3:15 P.M. "The Absolute Viscosity of Water," report of Committee on Standards, EUGENE C. BINGHAM, *chairman*, Lafayette College.

8:15 P.M. "The Elasticity of Protoplasm," WILLIAM SEIFRIZ, University of Pennsylvania.

8:45 P.M. "The Fluidity of Liquids, Part II," S. E. SHEPPARD and R. C. HOUCK, Eastman Kodak Company.

9:15 P.M. "Notes on Some Liquids Proposed for High-Viscosity Standards," S. E. SHEPPARD, K. G. HICKMAN, and R. C. HOUCK, Eastman Kodak Company.

9:45 P.M. "A Contribution to the Theory of Thixotropy," ERNEST A. HAUSER, Frankfurt-am-Main, Germany.

Tuesday, December 30th

9:00 A.M. "The Viscosity Correction for the Coefficient of Discharge for the Flow of Liquids through Minute Orifices," P. H. SCHWEITZER, Pennsylvania State College.

9:30 A.M. "Flow of Liquids in Soils," CHARLES TERZAGHI, Vienna, Austria.

10:00 A.M. "Physical Conception in Theories of Plastic Flow," R. L. PEEK, JR., Bell Telephone Laboratories.

10:30 A.M. "Further Studies on Association," EUGENE C. BINGHAM and L. W. SPOONER, Lafayette College.

10:45 A.M. "The Orientation of Dipole Molecules in a Viscous Medium," J. W. WILLIAMS and J. L. ONCLEY, University of Wisconsin.

11:00 A.M. "The Flow of Sand and Particle Size," EUGENE C. BINGHAM and R. W. WIKOFF, Lafayette College.

11:30 A.M. "The Flow of Colloids," HANS KROEPELIN, Erlangen, Germany.

12:00 A.M. "The Thixotropy of Pseudoplastic Systems," A. DE WAELE, D. Gestetner, Ltd., Tottenham, London, England.

Additional papers were presented as follows:

"The Nature and Measurement of Frictional Forces," E. KARRER, B. F. Goodrich Company, Akron, Ohio.

"Viscosity Measurements in Molten Glass," H. R. LILLIE, Corning Glass Works, Corning, New York.

"Mathematics of Leveling," GEORGE S. HASLAM, New Jersey Zinc Company, Palmerton, Penna.

"The Law of Elasticity for Finite Deformation," H. HENCKY, Massachusetts Institute of Technology, Cambridge, Mass.

"The Relation between the Plasticity of a Two-Component Solid-Liquid System and the Degree of Wetting of the Solid by the Liquid," F. E. BARTELL and A. HERSHBERGER, University of Michigan, Ann Arbor, Michigan.

The nature of a number of the papers listed may be indicated by the following abstracts:

Bingham and Spooner have prepared tables which make it easy to calculate the fluidity of pure chemical compounds over the entire range from the freezing to the boiling point.

Bingham and Wikoff have worked out the laws of the flow of sand through a vertical capillary. The flow of dry sand is not affected by changes in temperature, which doubtless explains its use in ancient times for "hour glasses."

Eaton has studied the standard method of obtaining the softening-point of bitumen, showing how a correction may be made for differences in the rate of heating the sample. He also showed that further specification is desirable in order to obtain a uniform sample due to loss of volatile matter during melting.

Hauser presented a theory to account for the fact that certain gels may be changed to liquids, called by colloid chemists sols, simply by shaking them. This phenomenon is called by the word thixotropy derived from the Greek words mean-

ing "changed by touching." According to Hauser the thixotropic particles are scale-like in shape, which in the gel form an oriented structure somewhat like a stone wall.

Bartell and Hershberger demonstrated that there is a definite relation between the readiness with which a solid can be wet and the plasticity of a paste made from the solid in finely divided form. The behavior is closely connected with orientation of the molecules. Their paper included numerous experimental results presented in graphical form.

Lillie described the technic by which the Margules method is applied to the measurement of high viscosities, especially that of glass at high temperatures. He discussed the general viscosity characteristics of glass and made a comparison of the more common types.

The abstract of the paper by Williams and Oncley is as follows: The dielectric constant has been defined as a measure of the work done by an external electrical field in orienting molecules against the effect of their thermal agitation. It is found that in the case of a polar liquid there is a region in which the dielectric constant decreases with increasing frequency, the frequency region being dependent upon the size of the orienting molecule and the viscosity of the medium. This frequency region determines a time of relaxation for the molecules which has been evaluated, using Stokes' law for the rotation of a particle in a viscous medium. It appears, however, that there are several objections to the use of the ordinary coefficient of viscosity of the medium to measure the resistance offered to a rotating molecule.

In the derivation of Stokes' law it is assumed: (1) that the discontinuities of the fluid be small compared with the size of the rotating sphere; (2) that the sphere be smooth and rigid; (3) that the velocity of rotation of the sphere be small.

These conditions can hardly be assumed in the case under discussion. Experimental data were given to indicate the type of system to which the theory may properly be applied.

GOVERNMENT SCIENTIST ANNOUNCES FINAL VALUE FOR GRAVITY CONSTANT

The final value for the most accurate measurement ever made of the constant of gravitation, from which can be figured the mass of the earth and the force with which the earth pulls the moon, has now been determined by DR. PAUL R. HEYL, physicist of the Bureau of Standards, after seven years work. Speaking before the Philosophical Society of Washington, on December 6, 1930, Dr. Heyl announced that the value can be expressed by the fraction 6.670 over 100,000,000.

According to SIR ISAAC NEWTON'S law of gravitation, any two bodies in the universe attract each other with a force that is greater as they are more massive and less in proportion to the square of the distance separating them. The exact force is obtained in scientific units by multiplying together the two masses, dividing by the square of the distance between them and multiplying the results by the constant of gravitation. Accurate knowledge of the force of gravity is important in many branches of science, from the study of the paths of projectiles fired from guns to that of the motions of the stars. The physicist refers to the constant as G.

The first effort to determine G was by a Frenchman, PIERRE BOUGUER, in 1740, but success was not attained until 25 years later when an English astronomer, REV. NEVIL MASKELYNE, found the attraction of a Scottish mountain, Schiehallien, which has a short ridge running east and west and steep sides on the north and south. He observed a plumb bob on each side of the mountain, and, by comparisons with the stars, measured the amount that the mountain pulled the plumb line from the vertical. This value was only a rough approximation, however, because it was not possible to find with precision the mass of the mountain.

In the years 1797 and 1798, the English

physicist, HENRY CAVENDISH, first performed the experiment with small, known masses in the laboratory. With this method, two tiny balls are attached to the end of a little rod, and the rod is balanced at the end of a long thin wire. As two large masses of metal are brought near, the small balls are pulled toward them and the wire is twisted. A tiny mirror attached to the wire near the rod turns with it, and moves a spot of light reflected from it to a distant screen. Essentially this is the method used in the new determination at the Bureau of Standards.

The largest masses used by Dr. Heyl were steel cylinders weighing about 150 pounds each. The smallest were balls of gold, platinum, and glass, each weighing about two ounces. Though the attraction that the large masses exerted on the small ones was about the same as the weight of the ink in the period at the end of this sentence, this force was measured with an accuracy of a thirtieth of one per cent. Instead of merely measuring the displacement in the position when the large masses were far away and when they were near, Dr. Heyl set the small masses swinging back and forth and measured the time of their swing. This period of oscillation changed as the large masses were brought close.

Dr. Heyl's work has been largely inspired by DR. G. K. BURGESS, director of the Bureau of Standards, who had a personal interest in the problem. In 1901, when he was working for his doctor's degree at the Sorbonne, in Paris, Dr. Burgess performed the experiment for his thesis, and obtained 6.64 for the value of *G*. However, the work was done under pressure of time, and he was not satisfied with the result. Then, when he became director of the bureau, he saw to it that the experiment was done more accurately than ever before so Dr. Heyl was assigned to the problem, and given plenty of time and the best facilities.

In 1927 Dr. Heyl announced a preliminary value for the figure of 6.664, but then the work had been done only with the small balls of gold and platinum. Since then he has repeated the work with the glass balls, and these gave a somewhat higher value, so that the final figure, the mean of all three, is 6.670. Dr. Heyl attributes the difference to small experimental errors in the set-up, and not to any difference in the gravitational attraction for different materials. Experiments made some years ago by BARON ROLAND VON EÖTVÖS, an Hungarian physicist, showed very conclusively that there is no difference depending on material.—*Science Service*

SIMPLE CHEMICAL MAY REPLACE LIVER AS ANEMIA CURE

Good news for the pernicious anemia sufferer may result from the recently announced investigations of DRS. R. WEST and H. D. DAKIN, and MARION HOWE of Columbia University College of Physicians and Surgeons and Presbyterian Hospital, New York City. Doomed to eat half a pound of liver daily in order to remain alive and healthy, the anemia sufferers have found themselves longing for the predicted day when all our nourishment would be served in pills and capsules.

It was DRS. GEORGE R. MINOT, W. P. MURPHY, and colleagues at Harvard Medical School who made the life-saving discovery that eating liver was efficacious in the treatment of pernicious anemia. Almost immediately, wails were heard from patients who found liver eating a trial. Some of them were silenced by a potent liver extract developed by DR. E. J. COHN, also of Harvard Medical School. The extract, however, is costly, and most of the sufferers must keep on with their liver diet. Medical scientists, interested in the purely scientific as well as the practical problem, wanted to know exactly what it was in liver that was so effective in treating pernicious anemia.

Part of the answer has now been given by the Columbia investigators. From liver they isolated a crystalline salt which is active in pernicious anemia. Analyzing this salt, they found two chemicals, beta-

hydroxyglutamic acid and hydroxyproline, which are probably fragments of the active material. How these two are combined in the liver and whether any other substances are combined with them has not yet been determined.

The practical application of this work is still in the future, but it seems possible that the synthesis of the active principle of liver may eventually be effected. When that has been accomplished, large-scale manufacture of a relatively cheap product may be expected.—*Science Service*

MELLON INSTITUTE ANNOUNCES INDUSTRIAL FELLOWSHIP ON SUGAR

DR. EDWARD R. WEIDLEIN, director, Mellon Institute of Industrial Research, has announced that the institution has lately begun a broad investigation into possible industrial uses for raw and refined sugar. The research will be carried on by a Multiple Industrial Fellowship that will be sustained by The Sugar Institute, Inc., of New York, an organization that represents the cane sugar refiners of the United States.

The comprehensive program of investigation will be supervised by DR. GEORGE D. BEAL, assistant director of Mellon Institute, and by DR. GERALD J. COX, senior industrial fellow. They and the scientists who will be under their direction in endeavoring to find and to develop uses for sugar in various industries will have the close advisory collaboration of DR. LEONARD H. CRETCHER, the sugar specialist who is the head of Mellon Institute's department of research in pure chemistry.

According to Dr. Weidlein, various studies made by private research workers have already indicated results of industrial promise; these findings will be carefully studied in the laboratories of Mellon Institute. Most of these proposals relate to applications for sugar in such technologic practices as wood preservation, textile finishing, and the manufacture of adhesives. Sugar is thought to merit searching investigation as a basic raw material for employment in various branches of chemical industry.

Four chemists, headed by Dr. Cox, have begun the initial scientific research of the Industrial Fellowship. Additions will be made to this staff, as needed, from time to time.

NATIONAL ADVISORY COMMITTEE ON EDUCATION

The *Bulletin of the American Association of University Professors* reports that the Steering Committee of the National Advisory Committee on Education has adopted the following fundamental principles:

I. The federal government has an obligation to aid public education in the states.

II. While the educational obligations of American governments upon every level—federal, state, and local—are equally full and binding, these obligations ought, in fact, to be discharged in a manner considerably different on each governmental level.

III. The federal government should render large intellectual assistance to the states in matters of education through research, collection and dissemination of reliable information, particularly with reference to those types of intellectual service which the states and the local communities cannot render to themselves.

IV. The federal government should give some financial aid to education in the states, but in a manner that will not violate other fundamental educational, political, social, and economic considerations basic to sound public policy.

V. Financial grants to states in aid of education as a whole should supplant special grants for the stimulation of particular types of training of benefit to special groups of the population.

VI. In the field of education at least, matching federal money grants, whether general or special, with state funds is a policy to be favored.

VII. It is unwise to centralize in the

federal government, as opposed to the state and local governments, the power of determining the social purposes to be served by schools or of establishing the technics of educational procedure.

VIII. Modifications of the federal means of aiding education should include provisions to assure adequate periods of transition.

IX. Agencies created by the federal government to meet new needs should be granted the autonomy and financial facilities necessary to overcome the inertia of traditional practice.

X. New participations of the federal government in education, designed to meet changing economic, social, and political conditions, should be inaugurated under tentative policies, regarded frankly as experimental, and subject to revisions as circumstances warrant.

The Steering Committee, as composed of S. P. CAPEN, FRANK CODY, L. D. COFFMAN, J. W. CRABTREE, W. M. DAVIDSON, C. H. JUDD, U. W. LAMKIN, C. R. MANN, J. E. RUSSELL, W. F. RUSSELL, HENRY SUZZALLO, and GEORGE F. ZOOK, also drafted seven definite proposals for federal action as follows:

1. Increase the federal appropriations for educational research and information service by the Office of Education, by the Federal Board for Vocational Education, and by the Extension Service and the Office of Experiment Stations in the Department of Agriculture; and provide ample means to these offices for supplying to all concerned the results of research and statistical studies through publications and conferences.

2. Create an adequate federal headquarters for educational research and information, so organized as to serve both as a coöperating center for all federal agencies with respect to the educational aspects of their work, and as a reliable source of comprehensive, correlated, and accurate data on education for all concerned.

3. Provide one unallotted annual grant to the states of $2.50 per child under 21 years of age, with the sole restriction that these federal funds be used for support of educational operations, making each state responsible for budgeting the grant within the state school budget in such manner as, in the judgment of the state itself, will best develop all the talents of all the people.

4. Repeal all laws that give annual federal grants in any form to the states for special phases of education of interest to particular groups of the people, or that authorize federal officers to supervise state educational or research activities, approve state plans, or withhold funds in order to compel state compliance with federal requirements.

5. Provide that for the next five years each state must allot to each specific purpose for which it now receives federal funds as much of the new federal grant as is now received from the federal government for that purpose; and that after five years the state may allocate all federal monies received for support of educational operations as it decides will best promote its own educational program.

6. Require that each state submit each year to the appropriate federal office a financial audit and that it publish a report describing specifically how the federal monies have been used; and that the federal government publish all forty-eight reports in one volume for comparative study by all interested.

7. Readjust the amount of the flat per capita federal grant to the states for support of education at the end of each ten-year period as the new census figures, the past experience, and the then existing situation may indicate to be appropriate.

CHANGES IN ORGANIZATION AT THE UNIVERSITY OF CHICAGO

PRESIDENT ROBERT MAYNARD HUTCHINS has announced the intention of the University of Chicago to abandon the traditional organization in which a student spends four years acquiring a fixed number of credits which automatically entitle him to a degree. The old type of

graduate school also will be eliminated in the new order.

The present undergraduate college will be replaced by a new kind of college in which a student will be able to graduate whenever he can demonstrate by passing comprehensive examinations that he has acquired a general education. Whether the student needs only one or four years depends on his own ability; he will not be hampered by a rigidly uniform system.

This new kind of college cannot be developed over night, but the first step in the program has been approved. Reorganization of the university into the professional schools and five main divisions, which replace the old divisions of college and graduate school, has just been sanctioned by the faculty and the board of trustees.... The five main sections into which the university's work in arts, literature, and science will hereafter be divided are the Social Sciences Division, the Physical Sciences Division, the Biological Sciences Division, the Humanities Division and the College.....

President Hutchins emphasized the fact that the university will not rush into the new plan without careful working out of all details. But the faculty and administration are agreed on the basic policy that education must cut loose from a system that has remained essentially unmodified since universities were first established in America and which is no longer adapted to modern needs.

The revision of the curriculum and the establishment of satisfactory standards of achievement and workable methods of measuring the student's progress by carefully framed comprehensive examinations will require considerable time and labor on the part of the university, but the main outline of this system has already been tentatively established.....

The transition from what is now the college level to what at present is the graduate level will be an easy and natural one under the new method, instead of the abrupt change that now is made. The sharp line that hitherto has divided the graduate school from the undergraduate college will be removed and all the work in special fields above the "general education" level will be merged in the four divisions.....

Once in an upper division, the student will graduate by the same means that he entered—by passing a comprehensive examination. The professional schools will award all professional degrees and the divisions will be responsible for the award of all non-professional degrees, including the equivalent of the present bachelor's degree now granted at the end of four years of work. The bachelor's, master's, and doctor's degrees are to be granted on the recommendation of the entire division and not by one department.

The reorganization already in effect, which in a large measure establishes divisional rather than departmental autonomy, will mean an immediate encouragement of undergraduate teaching, for now the college, instead of the various departments, will control the budget devoted to general education. The job of the college will be that of teaching, and its funds will be devoted to that purpose; the faculty of the college will be expected to contribute to the improvement of general education.....

Four of the deans of the five new divisions have been named..... PROFESSOR HENRY G. GALE, formerly dean of the Ogden Graduate School of Science, is dean of the Physical Sciences Division....

The broad objects of the divisional reorganization, as explained to the University Senate by President Hutchins, are "to improve administration by placing greater responsibility on officers who are familiar with the work of their respective divisions; to reduce the number of independent budgets presented to and administered by the president's office, to promote coöperation in research, to coördinate teaching, and to open the way to experiments in higher education."

Significance attached to the immediate reorganization, so far as the university's

advanced work is concerned, is that research on major problems which cut across present departmental boundaries will be facilitated.....Another important result of the correlation of departments is that advanced students in specialized work will be able to acquire a thorough grounding in the fields closely related to their special interests.

The change from the present methods of courses and credits cannot be made abruptly, and the university authorities now think that they may be required to let the old type of effort overlap the new methods for a period after the latter is put in effect. Some "credit bookkeeping," as a means of enabling a student to measure his achievement and also to protect students who may wish to transfer to other institutions operating under present methods, may be required.—*School and Society*

EUROPEAN STUDY TOURS FOR AMERICAN EDUCATORS

The International Institute of Teachers' College, Columbia University, coöperating with the *Zentralinstitut für Erziehung und Unterricht* in Germany, the Pedagogical Department of the Second University of Moscow in Russia, and the Ministry of Public Instruction in France, is planning a series of study tours for American schoolmen and educators in the summer of 1931. The tours will be to Russia beginning in Moscow on June 15th and continuing for six weeks; to Germany beginning in Bremen on June 22nd and continuing for six weeks; and to France beginning about June 1st and continuing for six weeks..... These tours are organized under the auspices of the respective educational authorities in Germany, Russia, France, and England. The leadership is divided between Teachers' College, Columbia University, and the educational authority in the various countries. The purpose of these trips is to provide American teachers with direct insight into the life and organization of foreign school systems. The tours are so organized, however, that liberal opportunity is afforded members of the groups for intimate contact with many other phases of life and culture in foreign countries, such as music, art, drama, industry, agriculture, commerce, and politics.

University credit may be granted to participants in these tours, provided the requirements for credit are met.

Steamship reservations must be made through DR. THOMAS ALEXANDER, International Institute, Teachers' College, Columbia University.—*School and Society*

ENROLMENT OF TEACHERS IN SUMMER SCHOOLS

More than 421,000 teachers, or about 45 per cent of the nation's combined administrative, instructional, and supervisory staffs of public, elementary, and secondary schools, took special courses last summer, according to a survey made recently by the National Education Association. The figures are based on the enrolment returns of 649 summer schools throughout the country. More than half the teachers taking courses attended lectures in educational theory and practice.

It was estimated that this year there were 942,025 teachers, supervisors, principals, and administrative officers employed in the public schools.

The number of teachers continuing their studies during the summer months was reported increasing constantly. Summer school attendance of teachers ten years ago was only 50,000 persons, it was said. By 1928 the figure had grown to 410,000 teachers. In 1929 it reached 415,000.—*School and Society*

SOUTH DAKOTA EDUCATION ASSOCIATION

The Science Section of the South Dakota Education Association met at Sioux Falls from November 24 to 26, 1930, inclusive. A program on "Needed Changes in Science Content, Organization, and Finance for South Dakota" consisted

of the following papers: "Science Teaching and Curriculum Problems," DR. OTIS W. CALDWELL, director, Institute of School Experimentation, Columbia University, New York City; "Science Teaching in the Elementary Schools," GRACE HAAS, Sioux Falls; "Is the Science Club a Vital Factor in Science Education?" AUSTIN PARK LARRABEE, Yankton; "Curriculum Construction for South Dakota," J. H. JENSEN, Aberdeen; "The Garvan Prize Essay Contest," B. A. DUNBAR, Brookings; "Creating Interest in Historical Chemistry by Subject Development Rather than Biographical," ARTHUR M. PARDEE, Vermilion; "Magazines for High-School Science Students," RALPH E. DUNBAR, Mitchell.

The group met for a business luncheon at the First Presbyterian Church on Tuesday noon, November 25th. Industrial excursions were made the last day of the session to the plants of the John Morrell & Co. Packing Plant and the Manchester Biscuit Co. Bakeries. This feature of the program was under the direction of F. V. RAYL of Sioux Falls.

ANNIVERSARY MEETING OF THE ROYAL SOCIETY

The Royal Society held its anniversary meeting, according to a report in *Nature*, on December 1st, at which meeting SIR ERNEST RUTHERFORD completed his term as president. The Copley medal was awarded to SIR WILLIAM BRAGG; the Rumford medal to P. DEBYE; Royal medals to O. W. RICHARDSON and J. E. MARR; the Hughes medal to SIR VENKATA RAMAN; and the Davy Medal to R. ROBINSON. In regard to the last award, SIR ERNEST RUTHERFORD referred to the fact that Professor Robinson "by his investigations of the chemistry of the alkaloids, has made notable additions to the knowledge of the structure of these complex substances, and by experiment extended by theoretical discussion he has strikingly indicated possible mechanisms on their formation in nature. He has also carried out brilliant synthetical work in connection with the coloring matters of flowers. His theoretical studies of the mechanism of organic reactions, in particular substitution in aromatic compounds, have led to results of great value in that they enable a very wide range of reactions to be considered from a common point of view."

LECTURES AT COOPER UNION

The Chemistry Teachers' Club of New York held their 201st meeting at Cooper Union on December 20, 1930. DR. G. EGLOFF of the Universal Oil Products Company was the guest speaker, his subject being "The Cracking Process in Gasoline and Gas Production."

On December 16th, the Cooper Union Student Chapter of the American Institute of Chemical Engineers, was addressed by MR. ERASMUS of the Union Carbon and Carbide Research Laboratories of Long Island on "The Relationship between Metallurgy and Chemistry."

DAKOTA WESLEYAN UNIVERSITY

GEORGE V. BOHMAN of Monmouth College has been added to the chemistry faculty as associate professor of inorganic chemistry.

PROFESSOR RALPH E. DUNBAR has been broadcasting a series of weekly talks every Friday morning at 10:00 o'clock over station KGDA, Mitchell Broadcasting Corporation. Topics that have been included in recent broadcasts are: "Anti-Freeze Solutions for Automobile Radiators," "The Utilization of Agricultural Wastes," "The Chemistry of Waste Products," and "Batteries and Blizzards." A question box has been a weekly feature of this science program.

HASTINGS COLLEGE CHEMISTRY CLUB

The chemistry club of Hastings College was fortunate in having DR. H. P. CADY, head of the chemistry department of

Kansas University, present his nationally known liquid-air demonstration at a recent meeting. He is a member of Sigma Xi and has done outstanding work in his researches on ionization in liquid ammonia and in methods of separating helium from natural gases, as well as in many other phases of inorganic and physical chemistry.

The club aims to present educational features along a chemical line at each program. Programs which have been of especial interest have included: demonstration of photography, at which a flash-light picture was taken and each process of the development explained on a chemical basis; and an experiment showing the characteristics and uses of explosives.

The chemistry club was organized in 1925 under the sponsorship of PROF. P. W. EVANS, head of the chemistry department of the college.

DR. KOCH LECTURES AT DE PAUL UNIVERSITY

On Sunday, December 14th, at the Morrison Hotel, DR. F. KOCH, head of the department of physiological chemistry, University of Chicago, and internationally known chemist, was guest of honor and speaker of the evening at the regular monthly dinner meeting of the Chemistry and Physics Society of De Paul University. Dr. Koch discussed, with the aid of lantern slides, his recent investigations on cholesterol irradiation. The separation of the ergosterol factor, its nature, potency, and use in antirachitic conditions were conclusively demonstrated. Attention was called to the complexity of the sterol molecule, its distribution in the organic world and the transformation of it into substances possessing vitamin D activity through the agency of ultra-violet light. Dr. Koch pointed out by way of illustration of this property, that rats merely licking the fur of their cage-mates previously subjected to ultra-violet irradiation would acquire sufficient antirachitic substance as to become totally immune for the time being to the ravages of rickets. This effect was attributed to the converted sterols present in the animal skin or fur

MISSOURI SCHOOL OF MINES

"Radium and Radium Poisoning" was the title of the general lecture given at Parker Hall Thursday, November 20, 1930, by PROFESSOR HERMAN SCHLUNDT, head of the department of chemistry at the University of Missouri.

Dr. Schlundt is well known for his scientific and technical work with radioactive substances. Besides discussing radium and its radioactive disintegration products, he presented information as to the physiological effects of radioactive substances. As little as ten micrograms of radium, valued at about one or two dollars, will produce very serious physiological effects. Insoluble radium compounds accumulate in the bony structure of the body with resultant slow disintegration of bone and tissue during the years. Dr. Schlundt has developed very delicate instruments for measuring the small amounts of radium in individuals suffering from radium poisoning. Amounts as small as one microgram can be detected in respirative or other products of the body. It was pointed out that no new cases of radium poisoning in the luminous paint industry have developed during the last decade, and patients who had been afflicted some 15 years ago during its early days are slowly eliminating the poison. Experiments are being carried out at present for hastening the elimination process. Methods of treating the radium paint to make it non-toxic at the time of application were described.

The lecture was sponsored by the Ira Remsen Society and a dinner in honor of the speaker was given by Sigma Xi.

The department of chemistry entertained the Rolla Section of the Missouri University Chapter of Sigma Xi on December 9th with a progress report on research work being done in the

department. MR. P. H. DELANO reported on a pentode vacuum tube potentiometer; DR. H. L. DUNLAP spoke on the solubility of salts in alcohols; DR. C. L. MONROE reported on electrolysis through glass; and DR. W. T. SCHRENK spoke on the electrolytic depositions of lead dioxide.

MR. H. E. WIEDEMANN, Missouri state chemist and consultant of St. Louis, Mo., told a few of his varied experiences as a consulting chemist during the last 25 years, in a talk before the Ira Remsen Society, December 3rd. His talk was informal in nature, but covered a multitude of incidents, no two of which were alike. Consulting work and court room cases furnish the high spots of interest in the career of such a free-lance chemist, analytical work being more or less routine. Mr. Wiedemann's description gave the student chemist a better idea of what the business of chemistry looks like from the inside.

WASHINGTON UNIVERSITY

The celebration of the 300th anniversary of the first recognized use of cinchona was held October 31st–November 1st at the Missouri Botanical Garden, with which Washington University's department of botany is connected. "The History of Cinchona" was reviewed by prominent speakers. Addresses were also given by DR. M. KERBOSCH, director, Government Cinchona Estate and Cinchona Experimental Station, Java; by DR. FREDERIC ROSENGARTEN, past president of the American Chemical Society; by DR. WILBUR L. SCOVILLE, Detroit, Mich.; others on "The Cinchona Alkaloids"—the industry, the pharmaceutical preparations, and the minor alkaloids of the bark.

PROFESSOR L. MCMASTER spoke over radio station KMOX, Sunday, December 7th, on the "Disintegration of the Atom." PROFESSOR A. L. HUGHES of the department of physics spoke at the same time on "Cosmic Rays."

ARTHUR B. TILLMAN of the school of engineering and MATHILDE L. DAVIS of the college of liberal arts received last academic year the highest grades in general chemistry and their names will be engraved on the Alpha Chi Sigma alumni tablet in the department of chemistry library.

DR. L. P. KYRIDES and MR. T. S. CARSWELL of the Monsanto Chemical Works gave a lecture and demonstration on glass blowing before the Alchemist Society of the department on December 11th.

DEPARTMENT ACTIVITIES AT THE COLLEGE OF THE CITY OF NEW YORK

December 5th was "High-School Day" at the Commerce Center, College of the City of New York. Several thousand representative students from the various high schools of New York City attended. The exercises consisted of descriptive lectures in the auditorium, athletic exhibitions in the gymnasium, and a survey of the whole plant. PROFESSOR ROSS A. BAKER, associate professor in charge, and the members of the staff of the department of chemistry of the Commerce Center, together with numerous student assistants, had many instructive and interesting demonstrations working in all the laboratories. Professor Baker gave successive groups a brief talk and some spectacular demonstrations in the lecture room.

The fifth annual dinner of The Baskerville Chemical Society was held on December 20th. The main speaker was PROFESSOR HERBERT R. MOODY. The officers of the society for 1931 are: F. L. WEBER, *president;* M. J. KILPATRICK and M. NEIDLE, *vice presidents;* D. LIFSCHITZ, *secretary;* C. A. MARLIES, *treasurer;* P. M. APFELBAUM, *editor.*

CHEMISTRY RESEARCH AT THE STATE UNIVERSITY OF IOWA

A considerable variety of research is being conducted at the State University of Iowa among the nine divisions in

which the chemistry department is organized.

The analytical division is interested in accurate methods of analysis, with pure substances, studying equipment, oxidation-reduction potentials, precipitates with the microscope and nephelometer, and co-precipitation phenomena by quantitative spectroscopic methods.

In the division of biochemistry, including pathological chemistry, special attention is given to studies of the chemical functions of the human body in both health and disease.

In the division of industrial chemistry and chemical engineering the research work includes: (1) problems arising in the manufacture of illuminating gas and its by-products and in the use of fuels in general; (2) work in theoretical chemical engineering, such as the measurement of heat flow in evaporation, drying, and similar processes, and the development of filtration constants.

In the division of inorganic chemistry theoretical studies are being made of the solubility of substances in solvents, such as liquid sulfur dioxide, liquid nitrogen tetroxide, and carbon tetrachloride. Attention is given to the X-ray investigation of solutions relative to a theory of solution. A study is also being made of the preparation of pure materials and of the valence changes of sulfur.

In metallurgy a study is being made of alloy systems not previously investigated. The effects of different metals on the properties of brasses and bronzes are examples. A study is also being made of the materials used in dentistry.

The work in organic chemistry is devoted to the study of the structural relations of certain types of compounds, with the purpose of determining the causes of special molecular rearrangements and the particular structures that are responsible for these changes. Such changes have a practical bearing on the reactions employed in the preparation of various synthetic compounds, such as dyes, antiseptics, and explosives. Emphasis is placed on the establishment of the principles involved.

In physical chemistry theoretical and experimental studies are being made of various physico-chemical phenomena. Among these are problems in adsorption of organic vapors by charcoal, of interest in the purification of gases and in defensive gas warfare; the free energy changes in chemical reactions; special studies in catalysis by metals and metallic oxides; conductivity measurements and studies in colloid chemistry.

In toxicology, the action of poisons is studied; their localization in the organism and their detection.

In water and sewage chemistry, scientific methods of water and sewage analysis and the practical treatment of water, sewage, and trade wastes are subjects of investigation. The research work is theoretical and practical to make the results of advantage to the student who does the work and to the public.

Seamless, Endless Tube of Copper, Zinc, or Iron, Made by Electrolysis. By forever pulling off the metal sheath as it is deposited out of solution on an iron alloy core Prof. Jean Billiter of the University of Vienna makes seamless and endless tubing of copper, zinc, and iron. But this, his first method, was too slow, he recently told the American Electrochemical Society; only a few inches of tubing could be made in an hour. So a faster method was devised. A lead core is now run continuously through the solution and metal is deposited on it as the core moves. Then the soft lead is melted away and the copper, zinc, or iron tubing left. A tube five yards long and nearly one-tenth of an inch thick can be made in 24 hours.—*Science Service*

Recent Books

An Introduction to Chemistry. JOHN ARREND TIMM, Yale University. Foreword by JOHN JOHNSTON. First edition, McGraw-Hill Book Company, Inc., New York City, 1930. xviii + 561 pp. 161 figs., 6 portraits, 74 tables, over 400 footnote references to the literature. 13 × 20 cm. $3.50.

The purpose of this book as asserted in its preface, in the foreword, and in an article by its author published in JOURNAL OF CHEMICAL EDUCATION, **6**, 1316 (1929) is to serve "those students whose major interests lie elsewhere" than in chemistry; who may wish to acquire in a course something of the "methodology and philosophy of science in general and of chemistry in particular." It is not expected that these students shall perfect themselves in the use of the tools of the chemist but rather that they shall become familiar with what the tools are, how they have been fashioned, the manner of their use, and what has been accomplished by their aid. The author seems confident that these expectations can be realized without laboratory work as an accompaniment of the course, and without the "cruel waste of time" involved in learning to write equations, in solving problems, or in attempting "the development of a certain degree of mental dexterity. . ." Looming large upon the title page are the words A PANDEMIC TEXT. This characterization, unless words are but scraps of paper, signifies that the presentation is such as would appeal to every one.

The book embodies subject matter used in a course offered at Yale. This matter is arranged upon a substantial framework constructed of fundamental theoretical concepts in use by chemists and physicists of the present day and moment. In connection with this presentation of theory there is a plenitude of descriptive and illustrative material. The author has kept faith in his promise to set these things forth as they have taken form in the minds of men and has pointed out both the rational bases upon which many of our theories rest and the reservations with which they should be accepted. The style throughout is lucid and attractive, the feeling of the reader being that the author has done a thoroughly good piece of work of its kind. A feature of the book especially to be commended is the continuous reference of the student to the literature. The citations are not only numerous but are so selected that they alone give a very wide range of informational material as well as due appreciation of the ways in which men of science carry on and make record of their accomplishments. While commenting upon the general make-up of the book mention should be made of its excellence from the viewpoint of a product of printer and publisher.

The precise niche which this work should occupy in the educational scheme is not easy to designate. The extent to which Professor Timm's objections may be either profitable or possible certainly is controversial. To many persons these objectives will seem to be aspirational rather than practically attainable. Nevertheless it is not to be denied that with his obvious enthusiasm for the task Professor Timm may himself achieve the objectives measurably, while it is self-evident that the success which will attend the efforts of others in an undertaking of this sort must be commensurate with their own enthusiasms. Whatever the part played by the attitude of the teacher, the fact still remains that if textbook content and organization are to count at all these must be suited to classroom constituency. In grade of difficulty this book is in no sense subelementary, but upon the contrary comparable to textbooks which in recent

years have been put out for the use of students doing their second year of college chemistry. If this appraisal is just it is certain that the book cannot be used effectively with heterogeneously composed groups. It is much more likely to fit in where through selection the class is composed of students who have more than ordinary backgrounds in mathematics and physical science and who at the same time possess mental maturity of the sort which engenders real interest in the philosophical aspects of things. These considerations, together with the comprehensiveness of the materials offered, would seem to make a use of the term *pandemic* quite inapplicable; *panchemic* might be a more accurately characterizing word. Aside from all comments such as the above the fact remains that the book does organize the fundamentals of chemistry in a different way which not only is refreshing, but which should exert an influence upon textbook writing in the future. Every teacher of chemistry should read it with interest, whether or not he may find it suitable for classroom use.

O. F. STAFFORD
UNIVERSITY OF OREGON
EUGENE, OREGON

General Chemistry. H. I. SCHLESINGER, University of Chicago. Second edition, Longmans, Green and Co., New York City, 1930. xi + 847 pp. 47 figs. 14 × 20.5 cm. $4.00.

Most teachers of chemistry are aware that we are on the eve of a revolution in the methods of teaching the science. This book foreshadows that event, not so much in radical departures in its own make-up as in its implications, in the suggestions which may be read between the lines, and in its forward-looking points of view.

The second edition has adhered to the fundamental policy of the first in furnishing students who have studied elementary chemistry in the high school a different approach to the subject and in presenting it as a growing science, still full of questions without final answers. The improvements over the first edition consist of a much enlarged section on organic chemistry, the introduction of more historical and descriptive material, and a revision and simplification of the treatment of a number of topics. The appendix, in the form of a tabular summary of properties of inorganic compounds, is a noteworthy addition in itself.

Written specifically for the student who has had a high-school course in chemistry, it is not given to the use of artificial means of stimulating interest; there are no "trick" ways of solving problems. On the contrary, it pays the student the compliment of assuming him to have a measure of common sense and healthy good judgment. Its treatment of theoretical topics is sound and, on the whole, simple and interesting. Many readers will miss the wealth of illustrations which are to be found in most modern textbooks; some will feel relieved at this omission. More diagrams and line drawings might have helped in places. The second edition contains more of these than did the first and those which do appear are pertinent and well chosen.

Its treatment of the kinetic-molecular behavior of gases, as well as the properties and structure of liquids and solids, is especially strong. The mathematical relations have been emphasized here, as elsewhere, to a sufficient extent to make the student realize the value of mathematics as a tool in chemistry.

In an excellent chapter on ionization the modern theory of complete dissociation of strong electrolytes is fitted in so smoothly that one does not recognize it as a recent development. This skilful transition of the recent into the orthodox is characteristic. One could wish that the same had been true to a larger extent in dealing with recent developments in atomic structure. The author missed an opportunity to do the same with simple quantum concepts and spectrum formation by atomic radiation.

Several points of specific interest might

be noted: a good discussion of hydrates, with their logical relation to complex compounds in general; a dropping of the term "water of crystallization," and a partial (unfortunately not complete!) submergence of those two old bogeys, "efflorescence" and "deliquescence"; a thoroughly up-to-date discussion of isotopes, with recent additions to the list; an excellent treatment of the topic of molecular and atomic weights. On the other hand, a rather unsatisfactory section on supersaturation mars an otherwise good chapter on solutions; the handling of hydrolysis seems needlessly cumbersome; the introduction of the important subject of valence as a subsidiary to the discussion of hydrogen does not seem to give it sufficient emphasis.

Without a doubt, the book should prove useful to teachers who do not want to introduce radically new methods and sequences but who wish to take full advantage of modern progress.

NORRIS W. RAKESTRAW

BROWN UNIVERSITY
PROVIDENCE, R. I.

Wave Mechanics of Free Electrons. G. P. THOMSON, Professor of Natural Philosophy, University of Aberdeen. McGraw-Hill Book Company, Inc., New York City, 1930. 172 pp. 53 figures. 15 × 23 cm. $2.50.

Although the subject of wave mechanics promises to be of such great interest and significance to chemistry, it has so far been a field into which only a very few chemists have dared venture. In perusing the dozen or so books which have been written on wave or quantum mechanics the average reader soon finds himself rather hopelessly lost in a bog of mathematics, and he is apt to feel that the gulf between the very theoretical physics and the very real test-tube chemistry is one that cannot be bridged for some time to come. It is therefore cheering to find a book like Professor Thomson's which emphasizes the experimental side of things and states a number of the important conclusions in a way that can be understood without a knowledge of the mathematics of waves or matrices.

The book represents the substance of lectures delivered at Cornell on the George Fisher Baker non-resident lectureship. In the words of the author "they are an attempt to state the principles and applications of the new wave mechanics in so far as these concern electrons not forming part of an atom, using the minimum of mathematics. . . . . This is the more important as it seems likely that the method of electron diffraction will find many applications in the next few years in physics and perhaps also in investigations of commercial interest."

The book opens with three chapters on the general theory of waves, de Broglie's wave mechanics and the theory of wave diffraction by crystals. These are brief and exceptionally clear, and may be recommended to any one who wishes to make his first plunge into the new physics and is not afraid of elementary calculus. There follows an excellent presentation of the experimental evidence for the wave nature of electrons. This is a subject on which Professor Thomson is particularly qualified to write since he is one of the chief contributors to it. Following several chapters which take up special cases of the interaction of electron streams and matter, the book concludes with a description of the application of electron diffraction to the study of physical problems such as adsorbed gas films, solid films, and polycrystalline surface layers.

The large number of plates which illustrate the nature of the effects obtained with electron beams, add greatly to the interest of the book and emphasize the reality of the results. The line drawings of apparatus and crystal structure also amplify the text in a way that makes the line of thought unusually easy to follow. A reading, either hurried or careful as the time permits, ought to repay any one

who wishes to keep up with the latest phases in our knowledge of the physical world. Aside from the value of the information, the book is inspiring in the very striking and unexpected nature of the results it presents. One is left with the feeling that we never know what undreamed-of possibilities may be awaiting us at every turn in the road to science.

DONALD H. ANDREWS

THE JOHNS HOPKINS UNIVERSITY
HOMEWOOD, BALTIMORE, MD.

Nutrition and Food Chemistry. BARNARD S. BRONSON, State College for Teachers, Albany, N. Y. First edition, John Wiley and Sons, Inc., New York City, 1930. viii + 467 pp. 34 figs. 15 × 23 cm. $3.75.

While being written primarily for classroom teaching, the book is quite readable for others interested in the field of nutrition. It presumes a background of elementary chemistry, but when a knowledge of organic and quantitative chemistry is needed, it is woven into the textbook discussion. Several chapters deal with the chemical composition of the major kinds of foods, fats, carbohydrates, and proteins. This section gives clearly and concisely that part of organic chemistry most useful for a thorough understanding of the composition of foods. The classifications of carbohydrates and of proteins are made especially clear.

Considerable quantitative chemistry, including a section on the significance of pH determinations, is given in the chapter on acid-base balance. The excellent discussion of the inorganic constituents of foods contains much recent information and is quite complete in its scope of material. Not least important are the suggestions given to help one in planning a diet which has the correct acid-base balance.

The chapter on the vitamins and deficiency diseases is very condensed but accurate and up-to-date in its information. Here, as all through the book, the complete lists of bibliographical references make the text all the more valuable for student and teacher.

The latter part of the book contains much helpful information about the production, composition, and nutritive value of certain foods, such as milk, butter, cheese, meats, cereals, vegetables, and fruits.

There is woven into the book the scientific background necessary for a complete understanding of the chemical principles underlying foods and nutrition. The author has fulfilled his purpose of "bringing together accurate information about foods and simplifying and interpreting it in such a way as to make the best modern thought available and comprehensible." The book would be most helpful either as a reference or text for classes of home economics students in foods and nutrition.

N. M. NAYLOR

IOWA STATE COLLEGE
AMES, IOWA

Textbook of Quantitative Analysis. WILLIAM THOMAS HALL, Associate Professor of Analytical Chemistry, Massachusetts Institute of Technology. John Wiley and Sons, Inc., New York City, 1930. vii + 279 pp. 42 figs. 15 × 23 cm. $2.50.

The preface states that the book represents a two-semester course in analytical chemistry as given at the Massachusetts Institute of Technology to chemical engineering students. The contents include, in addition to the usual general matter, procedures for about forty-two volumetric determinations and twenty-two gravimetric ones. With the exception of the Kjeldahl method these exercises are all devoted to the analysis of inorganic substances. There is a chapter of fifteen pages on potentiometric titration, including the use of the quinhydrone electrode. Buffer solutions are briefly mentioned but not discussed. The potentiometric method for determining pH values is given, and as special features there should be mentioned the two pages on the properties of logarithms and the

so-called "Home Problems" at the end of each chapter.

Volumetric analysis is presented first. The preface states that experience at M. I. T. shows that this is the better plan. The preface also gives the system of weighting the laboratory and class work and the home problems of the students in order to arrive at a just estimate of the semester grades to be given.

The procedures for carrying out the determinations are preceded by a paragraph or two in which the principles and chemical equations on which the methods are based are presented. This is a most excellent feature.

As a whole the procedures are up to date. The Willard Smith method for the separation of sodium and potassium is given but there is no mention of the methods of Kolthoff and others for the direct determination of sodium. The chapter on potentiometric titration is also lacking in most of the more modern methods.

The publishers are to be congratulated on the fine appearance of the book—with one exception, the illustrations. They are pretty bad.

Professor Hall evidently has no brutal friends to whom he submits his manuscript before printing. If he had, a number of bad spots, especially in the first half of the book, would have been noticed and eliminated. For example, in the section on methods of weighing, the well-known term zero point is used but not defined. There is given of course the experimental procedure for determining the zero point but in that paragraph it is called "rest point," with no hint that this is the same as "zero point" in another place. On page 5 the statement is made that a set of weights need not contain any weight smaller than 10 mg., though a few lines below is a reference to the occurrence of balances requiring 5 or 6 mg. riders. The section devoted to the calibration of pipets directs that the water from the mark be allowed to run into a weighed flask and then leaves the student to infer that flask and contents should be weighed. There is also no reference to the important point of adjusting the rate of outflow of burets and pipets. These and other evidences of lack of final editing detract, in the reviewer's opinion, from an otherwise excellent book.

C. W. FOULK

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The Chemical Analysis of Rocks. HENRY S. WASHINGTON, Ph.D., Geophysical Laboratory, Carnegie Institution of Washington. Fourth edition, John Wiley and Sons, Inc., New York City, 1930. xvi × 296 pp. 15 × 23 cm. $4.00.

The purpose of this book is to give to petrologists, mining engineers, and chemists who are interested in the study of silicate igneous rocks a series of simple yet exact methods of analysis for the important constituents of such rocks.

The methods are described in detail with discussions of the errors inherent in the methods and those likely to arise from carelessness or lack of skill in manipulation. This detail is calculated to make it possible for one with little previous knowledge of or experience in quantitative analysis to complete these analyses successfully without the help of an instructor in person. There is no attempt made to discuss the theoretical principles underlying the various procedures any further than that necessary for the intelligent use of the methods.

The text is divided into five parts: *Part I*, consisting of 28 pages, is introductory. *Part II*, 43 pages, is a description of the apparatus and reagents needed. *Parts III* and *IV*, 53 pages, contains a discussion of the sample and the operations involved in exact quantitative analysis. *Part V*, 151 pages, is the main chapter of the book. The first few pages are devoted to a brief outline of the determinations to be described fully later on in the chapter.

This is followed by a detailed description of the procedures used for determining the several constituents of igneous rocks. In the different portions of the sample taken for analysis the following determinations are made: (*a*) "main" portion —silica, alumina, total iron oxides, titania, lime, strontia, and magnesia, (*b*) ferrous oxide, (*c*) alkalies, (*d*) total water, (*e*) hygroscopic water, (*f*) phosphorus pentoxide, (*g*) manganous oxide, (*h*) total sulfur, zirconia, rare earths, and baria, (*i*) sulfur trioxide, (*j*) chlorine, (*k*) fluorine, (*l*) carbon dioxide, (*m*) chromium. Following these is a brief discussion of and references for the determinations of vanadium, copper, nickel, boron trioxide, and beryllia.

The text is supplemented by frequent references to standard works and journal literature dealing with the subject.

Perhaps the author is a little too partial to the older and sometimes less convenient forms of apparatus. For example he does not mention such a thing as an electrically heated and controlled oven which is generally considered as essential in analytical laboratories of today.

On page 194 we find the following statement, "The equation $\frac{S}{T} = n$ (or $\frac{T}{S} = n$) represents the weight of TiO_2 per cubic centimeter of the diluted test solution if the standard contains exactly 0.001 gram TiO_2 per cubic centimeter." This statement is incorrect so far as the formula in parentheses is concerned, as the concentration of the test solution compared to the standard as unity can be represented only by the inverse ratio of the depths of the two solutions $\left(\frac{S}{T} = n\right)$.

The general plan of the book is very good. The details of analytical procedure are exceptionally clear and practical. In the opinion of the reviewer the author has succeeded admirably in carrying out the primary purpose of the book. While conservative, the book has been brought up to date in methods and procedure. One very commendable feature is that all the methods described and recommended have been thoroughly tested and found reliable by the author himself. While it is intended more especially for petrologists and mining engineers, the book might very well be used as the basis of a course in gravimetric quantitative chemical analysis.

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Curriculum Problems in Industrial Education. FRED C. SMITH, Registrar and Lecturer on Vocational Education, Harvard University. Harvard University Press, Cambridge, Mass., 1930. ix + 145 pp. 10 figures, 11 tables. 15 × 23 cm. $1.00.

Education, in keeping with the other factors of life, has its fads and fancies. The fad today is curriculum revision, the fancy is the group-conference method for the mutual propagation of knowledge. Curriculum Problems in Industrial Education is just another bulletin professing to set up a new technic for solving the oft-vexing problem of course content in vocational classes. The author proposes to build an industrial curriculum by using the group-conference procedure for determining what should be taught. This he does and a curriculum for the machinist trade emerges, with repetitions of his proposed technic bringing forth less extensive recommendations for the building construction industry, electrical industry, and industrial chemists. Unfortunately, the proposed curriculum bears little resemblance to the findings which came out of the conferences and questionnaire used to verify the opinions of the conferences. Rather the course in science looks strangely like the table of contents of any standard physics book. The same criticism holds for the proposed course in mathematics. Throughout the bulletin the author is unscientifically dogmatic. Many of his statements are open to controversy and are unsubstantiated. If this study is

intended as a piece of scientific research in education it falls short of its purpose. In so far as chemical education is concerned the report has little value. No new contribution has been made.

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Podrecznik Chemji. STANISLAW PLESNIEWICZ. Ksiaznica-Atlas, Warszawa, 1930. 308 pp. 16 × 23 cm.

A copy of this Polish chemistry textbook for high-school students is in the editorial office of the JOURNAL OF CHEMICAL EDUCATION. Any one interested may borrow it for inspection.

M. W. G.

MISCELLANEOUS PUBLICATIONS

Locating Educational Information in Published Sources. WALTER S. MONROE, Director, THOMAS T. HAMILTON, JR., Assistant, and V. T. SMITH, Assistant, all of the Bureau of Education Research, University of Illinois, Urbana, Ill. Bulletin No. 50. *University of Illinois Bulletin*, 27, No. 45 (July 8, 1930). 142 pp. 15 × 23 cm. $0.50.

This bulletin has been prepared as an aid in assisting the research worker in locating information on education in published sources. Chapter 2 describes the organization of a library and the general aids for reference work. Chapters 3 and 4 deal with educational periodicals and other types of publications. Chapter 5 contains a bibliography of bibliographies.

Bibliography of Research Studies in Education: 1928-1929. U. S. Dept. of the Interior, Office of Education Bulletin No. 23. Prepared in the Library Division of the Office of Education by EDITH A. WRIGHT. U. S. Govt. Printing Office, Washington, D. C., 1930. (For sale by the Superintendent of Documents, Washington, D. C.) 308 pp. 15 × 23 cm. $0.40.

Accredited Secondary Schools in the United States. U. S. Dept. of the Interior, Office of Education Bulletin No. 24. Prepared by MARGARET J. S. CARR, Division of Statistics, Office of Education. U. S. Govt. Printing Office, Washington, D. C., 1930. (For sale by the Superintendent of Documents, Washington, D. C.) 152 pp. 15 × 23 cm. $0.25.

Land-Grant Colleges and Universities, Year Ended June 30, 1929. U. S. Dept. of the Interior Bulletin No. 29. Prepared by WALTER J. GREENLEAF, Associate Specialist in Higher Education. U. S. Govt. Printing Office, Washington, D. C., 1930. (For sale by the Superintendent of Documents, Washington, D. C.) 87 pp. 15 × 23 cm. $0.15.

Record of Current Educational Publications. Comprising Publications Received by the Office of Education, April–June, 1930. U. S. Dept. of the Interior Bulletin No. 32. Compiled by MARTHA R. MCCABE, Acting Chief, Library Division. U. S. Govt. Printing Office, Washington, D. C. (For sale by the Superintendent of Documents, Washington, D. C.) 49 pp. 15 × 23 cm. $0.10.

Annual Report of the Commissioner of Education for the Fiscal Year Ended June 30, 1930. U. S. Dept. of the Interior. U. S. Govt. Printing Office, Washington, D. C., 1930. (For sale by the Superintendent of Documents, Washington, D. C.) 47 pp. 15 × 23 cm. $0.10.

Smithsonian Institution Reprints. U. S. Govt. Printing Office, Washington, D. C., 1930.

The following reprints from the Smithsonian Report for 1929 have recently come to the attention of the JOURNAL OF CHEMICAL EDUCATION:

"The Physics of the Universe," by SIR JAMES JEANS.

"What Is Light?" by ARTHUR H. COMPTON.

"Artificial Cold," by GORDON B. WILKES.

"Photosynthesis," by E. C. C. BALY.

"Newly Discovered Chemical Elements," by N. M. BLIGH.

"Synthetic Perfumes," by H. STANLEY REDGROVE.

These reprints may be obtained free of charge from the Smithsonian Institution, Washington, D. C.

Government Chemists Test New Anti-Freeze. Will people get chronic or acute poisoning if wood alcohol is used generally as an anti-freeze mixture for automobile radiators? This is one of the questions which government scientists are trying to solve as a result of the proposal to introduce synthetic methanol as an anti-freeze next winter.

Methanol, as wood alcohol is called by chemists, used to be made by distillation of wood. This made its cost high. By the new method, it is made by combining the deadly carbon monoxide with hydrogen, the raw materials being coal and water. This makes synthetic methanol very much cheaper than the product obtained by distillation. Whether it can be used safely in automobile radiators has yet to be determined.

When swallowed, wood alcohol is a poison which may cause blindness and death. Careless bootleggers have mistaken wood alcohol for the less deadly ethyl alcohol, with diastrous result to their clients. This use of the new anti-freeze is to be guarded against by giving it a distinctive color, it is planned.

However, the question remains whether the fumes could not get into the body either by absorption through the skin or by inhalation through nose and mouth, and thus cause disease and possible death. How much of the substance can get into the body in these ways, and how much will cause poisoning, either chronic or acute, must be determined.

It may be that the new anti-freeze can be used safely if certain regulations are followed and certain precautions taken, as in the case of the anti-knock gasolines. These contain a small amount of tetra-ethyl lead. When they were first introduced there was question as to whether people generally would be in danger of lead poisoning from the exhaust, and whether men selling it and working in garages where it was sold were risking their health. Cases of lead poisoning in the plants where the anti-knock mixture was made heightened the public anxiety. But scientists found that the only real danger was in the manufacturing plants and that even there, as in other lead industries, certain health precautions, if followed, would safeguard the workers.

A possibility exists of certain people being more susceptible to methanol poisoning than others, and of certain people having the kind of skins that would absorb more of it than others. This also will be investigated, said Dr. R. R. Sayers of the U. S. Public Health Service who is in charge of the investigation. Chemists of the U. S. Bureau of Mines at Pittsburgh will make chemical and laboratory tests, working with animals. The U. S. Public Health Service is making field tests on men who are now exposed to synthetic methanol.

Ethyl alcohol, closely related to methanol, which is methyl alcohol, is largely used at present as an anti-freeze in automobile radiators. Its chief disadvantage is that it evaporates quickly and must be constantly replaced. It is not poisonous like methanol, because man can develop a tolerance to it. Another popular anti-freeze is ethylene glycol, which is made synthetically from petroleum and has the advantages of both ethyl alcohol and of glycerin, also widely used as an anti-freeze. Ethylene glycol and glycerin are more expensive than ethyl alcohol, which in turn costs more than synthetic methanol. The latter is being made by three large companies who make over six million gallons a year.—*Science Service*